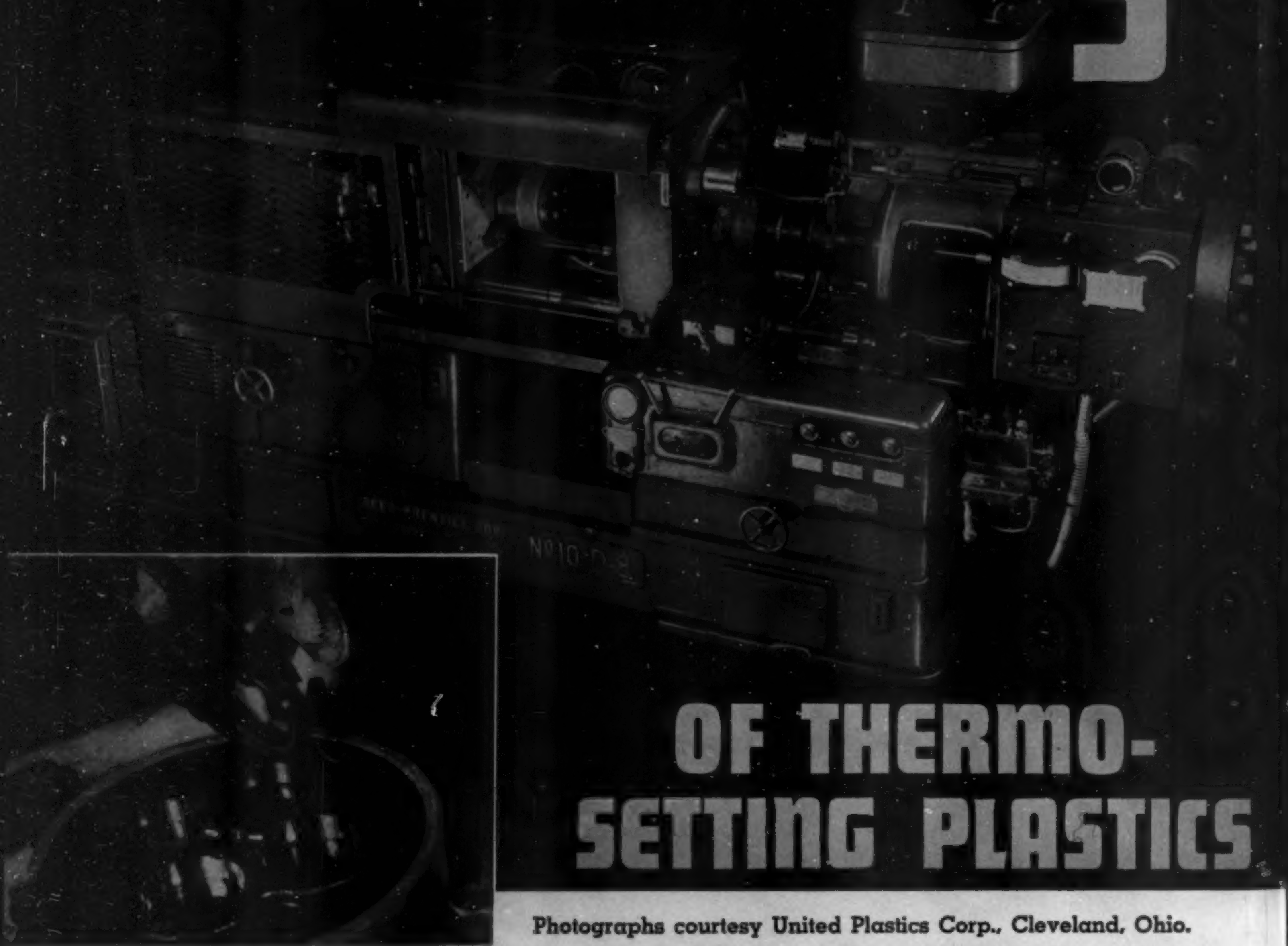
MODERN PLASTICS

mp

NOVEMBER 1942


A NEW LOW PRICE NOW MAKES THIS PLASTIC
OF THE FUTURE THE MATERIAL OF THE HOUR!
Loalin #1
POLYSTYRENE MOLDING COMPOUND
UNEXCELLED Electrical Properties
LOWEST Specific Gravity
ZERO Water Absorption
BASE PRICE — 30c per lb.
Inquiries Invited
"Loalin" is a reg. trade mark
CATALIN CORPORATION • ONE PARK AVENUE, NEW YORK, N. Y.

Jet Molding



OF THERMO-SETTING PLASTICS

Photographs courtesy United Plastics Corp., Cleveland, Ohio.

REED-PRENTICE Plastic Injection Molding Machines have proven their adaptability in a separate and distinct field. A newly patented process which uses a novel heater and nozzle design has made possible jet molding of thermo-setting plastic materials with the customary speed and precision of all Reed-Prentice molding machines.

Jet molding under license from Plastics Processes, Inc., Cleveland, Ohio, is now available, and Reed-Prentice machines which incorporate this process are now for sale to licensed users. It is also possible for licensed owners to rebuild their present Reed-Prentice machines to adapt them for use of thermo-setting plastics. Our engineers will gladly consult with you about this new process either in regard to purchase of new equipment or relative to conversion.

REED-PRENTICE CORPORATION 1213 W. 3d St., CLEVELAND, OHIO
75 WEST ST., NEW YORK CITY

WORCESTER, MASSACHUSETTS, U.S.A.

modern plastics

INCLUDING

Plastics ENGINEERING

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NOVEMBER 1942

VOLUME 20 NUMBER 3

• GENERAL INTEREST

• PLASTICS ENGINEERING

• TECHNICAL SECTION

• NEWS AND FEATURES

IMPACT STRENGTH

FOR THE *Winged Commandos*

Qualifications for Glider Pilot Training...1. Men between the ages of 18 to 35 inclusive, holding a currently effective C. A. A. Airman's Certificate, private grade, or higher. 2. Or, holding a C. A. A. Airman's Certificate, private grade or higher, that has lapsed since January 1, 1941. 3. Or, a certified statement showing completion of 200 or more glider flights. 4. Or, if you are a former aviation cadet or aviation student, who has completed at least 50 hours of total flying time, either dual or solo, at any Army, Navy, or other service flying school . . . *get in touch with your nearest recruiting office.*

Impact strength—the threat of the Winged Commandos! These intrepid air-troops will glide swiftly and silently to attack when the enemy least expects it.

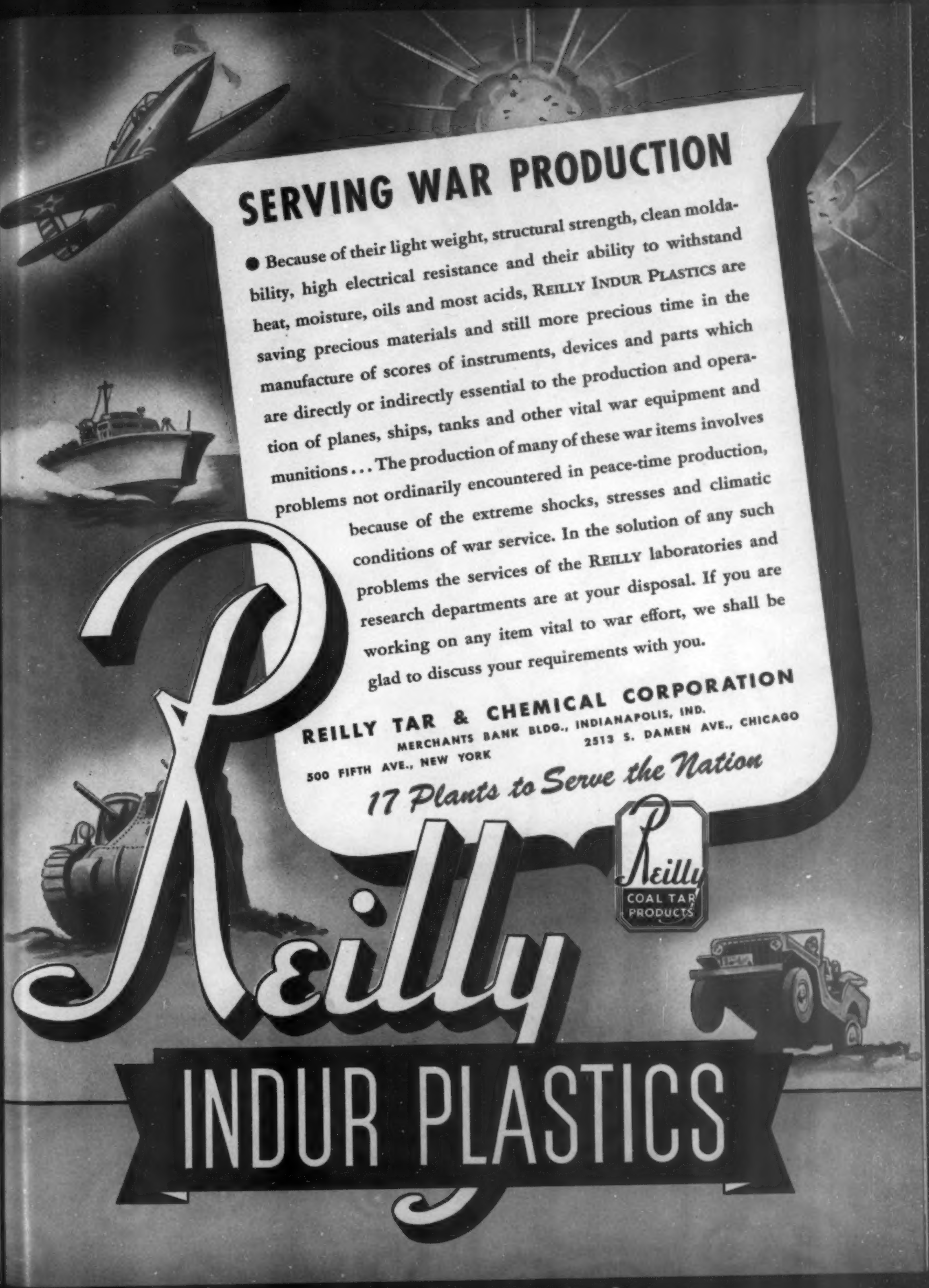
Impact strength—a prime military requirement in plastics for glider and 'plane cockpit enclosures, windshields and ports. And many of these vital parts are made of Aero-Quality Lumarith. Its impact strength at sub-zero temperatures exceeds, in some cases, the strength of other plastics at room temperature.

Super-tough . . . shatterproof . . . one of the lightest plastics known —Lumarith sheets and molding materials speed production. Lumarith is easy to mold and easy to form. Sheets can be formed into simple curves without heat. Lumarith resists crazing, is impervious to water, has excellent weathering qualities.

CELANESE CELLULOID CORPORATION

The First Name in Plastics

Celanese Celluloid Corporation, 180 Madison Ave., New York City, a division of **Celanese Corporation of America** Sole Producer of Celluloid* (cellulose nitrate plastics, film base and dopes) . . . **Lumarith*** (cellulose acetate plastics, film base, insulating, laminating and transparent packaging material and dopes) . . . **Lumarith* E. C.** (ethyl cellulose molding materials) . . . *Trademarks Reg. U. S. Pat. Off. . . . Representatives: Dayton, Chicago, St. Louis, Detroit, San Francisco, Los Angeles, Washington, D. C., Leominster, Montreal, Toronto.


SERVING WAR PRODUCTION
● Because of their light weight, structural strength, clean moldability, high electrical resistance and their ability to withstand heat, moisture, oils and most acids, REILLY INDUR PLASTICS are saving precious materials and still more precious time in the manufacture of scores of instruments, devices and parts which are directly or indirectly essential to the production and operation of planes, ships, tanks and other vital war equipment and munitions... The production of many of these war items involves problems not ordinarily encountered in peace-time production, because of the extreme shocks, stresses and climatic conditions of war service. In the solution of any such problems the services of the REILLY laboratories and research departments are at your disposal. If you are working on any item vital to war effort, we shall be glad to discuss your requirements with you.
REILLY TAR & CHEMICAL CORPORATION
MERCHANTS BANK BLDG., INDIANAPOLIS, IND.
500 FIFTH AVE., NEW YORK
2513 S. DAMEN AVE., CHICAGO
17 Plants to Serve the Nation
Reilly
COAL TAR PRODUCTS
Reilly
INDUR PLASTICS

THE 1943

PLASTICS

CATALOG

858 PAGES

MAY STILL BE ORDERED AT

THE SPECIAL PRE-PUBLICATION

PRICE OF $3 PER COPY

($5 on date of publication)

Shatter-proof plastic for *"flying dark rooms"*

Tray made of Celanese Celluloid Corporation's Lumarith, based on Hercules Cellulose Acetate Flake

PRELUDE TO A THOROUGH BOMBING: revealing last-minute photographs of the "target for tonight." To get such snapshots is one big job of the air-arm. To deliver them swiftly back to base, instantly ready for study by the bomber command, is why planes are equipped for developing the films *in flight.*

NEW DEVELOPMENT for these "flying dark-rooms" is a new film-developing tray, made of *cellulose acetate* plastic . . . cellulose acetate because it cannot be bullet-shattered (thereby ending one threat to men and delicate instruments) . . . cellulose acetate because it stays tough in Arctic or African temperatures . . . cellulose acetate because it saves pounds of weight.

UNIQUE IS THE COMBINATION of advantages in plastics made with a base of Hercules Cellulose Acetate Flake. What other plastic combines, for the products of war and peace, such lightweight toughness . . . such clarity and beauty . . . such resistance to acids, alcohols, chemicals and oils . . . and such great economy? As one of the nation's leading producers of cellulose derivatives from which plastics are made, we have technical and other booklets about cellulose acetate which you will find interesting and helpful. Your letter addressed to Department MP-11 will start this material on its way to you.

HERCULES

CELLULOSE ACETATE

★

TOUGH • FLEXIBLE • STABLE
LIGHTWEIGHT • ECONOMICAL • CLEAR

HERCULES POWDER COMPANY · *WILMINGTON, DELAWARE*
Incorporated

WHICH IS MORE IMPORTANT—WRITING THE COPY OR SELECTING THE MEDIA?

The Answer is—BOTH!

THERE is no competition between copy writing and media selection. The best in both activities is indispensable to successful advertising. Obviously the same degree of care used in producing a sales message should be employed in selecting the means to get that message before the right people. Guesswork, opinions and unverified claims have no place in media selection any more than careless phraseology and loose statements have in advertising copy.

Facts, decided by advertisers as essential in evaluating the advertising worth of media and in applying media to markets, are supplied in the reports issued by the Audit Bureau of Circulations. To buy advertising without this information would be like an attorney attempting to practice his profession without a law library.

This business paper is a member of the Bureau. Our A.B.C. reports tell how much circulation we have, how it was obtained, where it goes, an industrial or occupational analysis of subscribers, how much readers pay, the percentage of renewals and other facts that buyers need in order to select the media best adapted to their requirements. This information is verified by thorough audits of our circulation records, made annually by A.B.C. auditors. Advertising in this paper receives audited distribution.

SEND THE RIGHT MESSAGE TO THE RIGHT PEOPLE

Paid subscriptions and renewals, as defined by A.B.C. standards, indicate a reader audience that has responded to a publication's editorial appeal. With the interests of readers thus identified, it becomes possible to reach specialized groups effectively with specialized advertising appeals.

MODERN PLASTICS

Member of the Audit Bureau of Circulations ABC ***Ask for a copy of our latest A. B. C. report***

A. B. C. = AUDIT BUREAU OF CIRCULATIONS = FACTS AS A MEASURE OF CIRCULATION VALUES

Hold on to a chair

and read this

Do you feel like this, too?

Well, it's an unavoidable result of this mess the whole world is in. We will all have a continual hangover for a long time to come. That might not be so bad if we had only had some fun the night before.

Today, whenever we tell a customer of some new regulation covering the use of material we not only date the bulletin, we give the hour of the day—sounds like a newspaper office.

"FLASH—5 P.M. Oct. 30, 1942—phenol only available for A-10 or better, Cellulose Acetate allowance cut 50%."

What happens tomorrow will probably make liars of us all as of yesterday.
So be patient—we offer a blanket apology—for everything.

"A Ready Reference for Plastics" written for the layman, is now in a new edition. If you are a user or a potential user of molded plastics, write us on your letterhead for a copy of this plain non-technical explanation of their uses and characteristics. Free to business firms and government services.

BOONTON MOLDING COMPANY

MOLDERS OF PLASTICS · PHENOLICS · UREAS · THERMO-PLASTICS

BOONTON · NEW JERSEY · Tel. Boonton 8-0991

N. Y. Office—Chanin Bldg., 122 East 42nd Street, Murray Hill 6-8540

THESE BIG TOP PHOTOS TELL YOU ABOUT KYS-ITE'S BIG POSSIBILITIES

Strong as a Samson. KYS-ITE has four to five times the impact strength of ordinary plastics. It's molded from long pulp fibre and synthetic resin and can be preformed to shape before curing.

Light as a Midget. Even though KYS-ITE is as strong as a circus giant, it's as light as Barnum's Tom Thumb. Actually, it weighs only half as much as aluminum. Yet, it's resilient and sturdy.

Tough as a Gargantua. It's practically non-shatterable and almost impossible to chip in ordinary use. Even boiling it in salts, soaps and acids fails to disfigure or warp it!

Versatile as an Acrobat. The new KYS-ITE can be used for trays, business machines, refrigerators, radios, batteries and scores of other things. It has even been used for light metal machine parts!

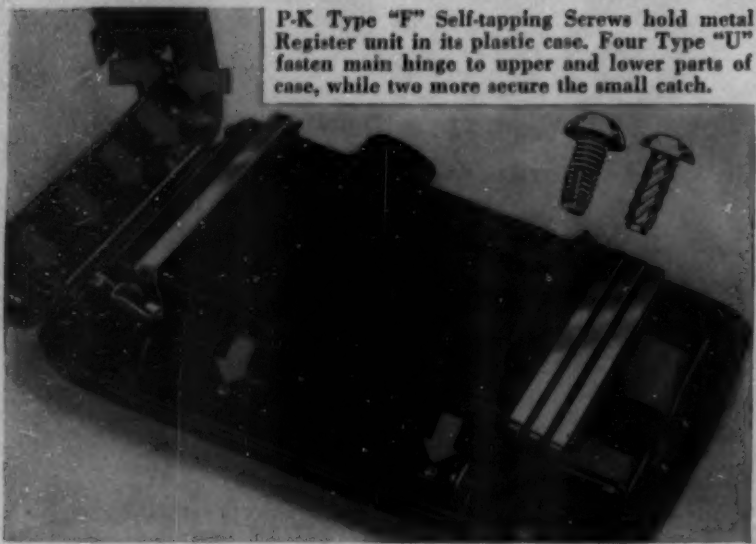
Silent as a Giraffe. Like the mute giraffe, KYS-ITE gives forth little sound. It's non-resonant and non-reverberating. That makes it ideal for uses where it's desirable to eliminate noise.

Colorful as a Clown. You can get KYS-ITE in a wide range of colors. And alcohol, greases or mild alkalies can't stain it! Just wipe with a damp cloth—and presto! It's as lovely as ever.

• LET KYS-ITE MOLD YOUR FUTURE •

KEYES FIBRE COMPANY, WATERVILLE, MAINE

IN CHANGING FROM *Metal to Plastic...*



P-K Type "F" Self-tapping Screws hold metal Register unit in its plastic case. Four Type "U" fasten main hinge to upper and lower parts of case, while two more secure the small catch.

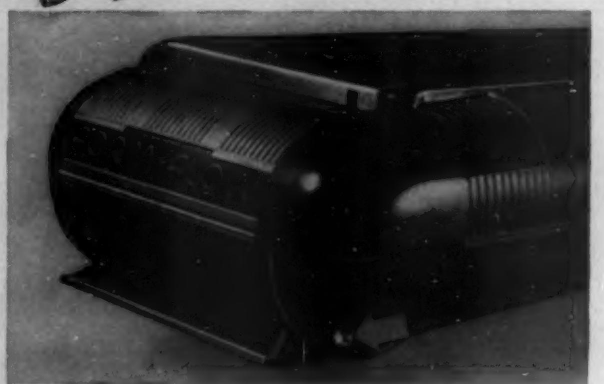
Standard Register simplified design . . . avoided tapping and lock washers . . . . by taking full advantage of P-K Self-tapping Screws

"IN redesigning several of our Registers to use plastic instead of metal cases, we took full advantage of Parker-Kalon Self-tapping Screws. With the different types of Self-tapping Screws, we were able to solve a variety of fastening problems. In one place we avoided design and construction complications. In others we avoided tapping operations and eliminated the need for lock-washers" . . . say Standard Register Company engineers!

Self-tapping Screws have helped to simplify fastening problems for scores of manufacturers who have changed from metal to plastic materials. They offer a combination of ease, speed and security that no other fastening device or method can match! One easy operation makes a strong fastening with Self-tapping Screws . . . merely drive the Screws into plain, untapped holes. They eliminate the need for metal inserts. They solve the problem of getting scarce taps. They stop the fumbling that goes with handling bolts and nuts, and placing lock-washers.

No matter what plastic material you're working with, or planning to "switch to" . . . be sure you try the *simple* Self-tapping Screw method before you put up with a more difficult one. Ask for a P-K Assembly Engineer to call and help you search out ALL opportunities to apply Self-tapping Screws. Or, mail assembly details for recommendations. Parker-Kalon Corporation, 190-200 Varick Street, New York, N. Y.

Two P-K Type "F" Screws fasten a spring steel catch to plastic case, and two Type "U" Screws hold a hinge plate on side of case.



Two Type "Z" Screws are used as trunions for a compartment door, eliminating need for a hinge and simplifying mounting of door.

A TYPE FOR EVERY METAL OR PLASTIC ASSEMBLY

PARKER-KALON

Quality-Controlled

SELF-TAPPING SCREWS

Give the Green Light • to War Assemblies

A BETTERMENT . . .

Not a Substitute

Push a button and you have world events before you . . . Flick a switch and you hear the best music of the ages—automatically played from a dozen recordings. Would you call the modern Radio-Phonograph Console a substitute for the gramophone of only a generation ago? Would you want to go back to the gramophone of Grandma's day?

Most manufacturers who have properly designed CONTINENTAL-DIAMOND NON-metallics into their products . . . to replace corrosive, costly, weighty and now hard-to-get materials likewise will rarely go back to the materials replaced.

C-D NON-metallics inherently possess unique characteristic combinations. VULCOID, for example, combines the strength, resiliency and machinability of Vulcanized Fibre . . . with the moisture resistance ability of laminated plastics . . . and the electrical insulating properties of both. The other four C-D NON-metallics possess equally advantageous characteristic combinations. Booklet GF-6 describes all of them. Send for it today.

When you are ready to discuss your specific "What Material?" problem, write, phone or wire for a C-D Laboratory Research Representative. He'll help you find the answer to product, process or performance BETTERMENT.

Continental-Diamond FIBRE COMPANY

Established 1895 . . Manufacturers of Laminated Plastics since 1911 — NEWARK • DELAWARE

Announcing

A NEW AND REVOLUTIONARY PROCESS IN THE INJECTION MOLDING OF PLASTICS.

the faster

Under C. D. Shaw Patents 2,296,295 and 2,296,296

JET MOLDING PROCESS

NOW AVAILABLE FOR LICENSE TO THE MOLDING INDUSTRY, AND ADAPTABLE TO ANY STANDARD INJECTION MACHINE.

Once a slow and costly process, the molding of plastics has now reached advanced stages of perfection. The injection method has been limited to *thermoplastic* material. Now our exclusive jet process brings new opportunities for high speed production in *thermosetting* as well as thermoplastic materials. Applied heat is scientifically and automatically regulated. Cylinders contain a constant, ready supply of free-flowing material, assuring quick-setting molded parts of clear, uniform quality. Plastic molding bottlenecks are eliminated. Production is fast, and uninterrupted. Mold costs reduced. And even the most intricate part designs are accomplished quickly, easily. Regardless of your plastic molding production schedule, our jet molding process can amplify it.

For Complete Details Regarding Licensing Arrangements Address All Inquiries To

PLASTICS PROCESSES INC.

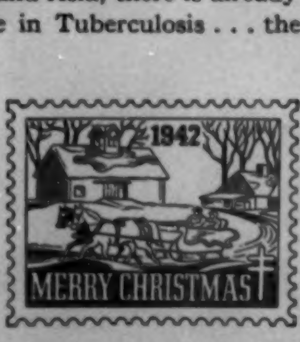
[illegible] Tower, Cleveland, Ohio

The Four Horsemen ride again

War has once again loosed the Four Horsemen of the Apocalypse upon the world . . . fire, famine, sword, and pestilence.

In the last war, the most deadly of these was *pestilence*. And today, in Europe and Asia, there is already a wartime rise in Tuberculosis . . . the dread TB that kills more people between 15 and 45 than any other disease.

You can help prevent a wartime rise of TB in our country — by buying Christmas Seals today . . . and using them every day from now to Christmas. *They fight Tuberculosis.*

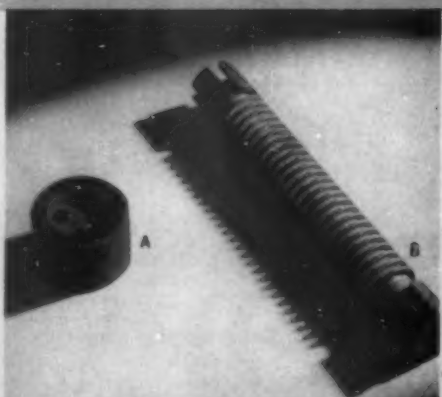


BUY CHRISTMAS SEALS

The National, State and Local Tuberculosis Associations in the United States.

Photo by U.S. Army Signal Corps

This Year's Best Selling Car



A — Connector plug — sawed, turned, and drilled.
B — Coil form — turned, milled, and threaded.

YOU'RE looking at this year's most popular automobile—the Army's "jeep". In its vitals are certain parts made of Synthane. This is only natural for the civilian predecessors of the "jeep" used Synthane too.

Synthane is a material of value to essential industries because of an unusually wide variety of properties, including resistance to corrosion from solvents, acids, salts and water, structural strength, light weight (half that of aluminum), hardness, excellent electrical insulating characteristics and ease and speed of machining.

After the war workaday opportunities for these properties will knock again on factory doors. In the meantime, to present users of Synthane and those with future applications, Synthane offers helpful information such as appears on the back of this sheet.

SYNTHANE CORPORATION, OAKS, PENNA.

Plan your present and future with plastics

SYNTHANE TECHNICAL PLASTICS

SHEETS • RODS • TUBES • FABRICATED PARTS

SYNTHANE

Bakelite — laminated

SILENT STABILIZED GEAR MATERIAL

General Characteristics of Synthane Grades

Here are some of the standard grades of Synthane Bakelite-laminated. We also make subgrades when one or two characteristics must be emphasized.

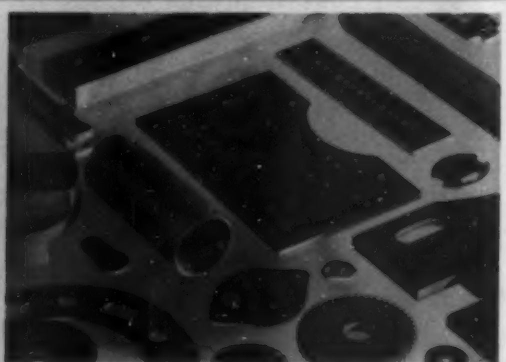
Paper Base Grades

	BASE	RESIN	CHARACTERISTICS
X	Kraft Paper	Hard	A strong paper base laminated material primarily intended for mechanical applications where electrical requirements are of secondary importance. Should be used with discretion when high humidity conditions are encountered. Not equal to fabric base grades in impact strength.
XP	Kraft Paper same as Grade X	Plasticized Resin	A paper base laminated material primarily intended for punching. More flexible and not quite as strong as Grade X. Moisture resistance and electrical properties intermediate between Grades X and XX.
XX	Cotton Rag Paper	Hard Greater % of Resin than Grade X	A paper base laminated material suitable for usual electrical applications. Good machineability.
XXP	Cotton Rag Paper same as Grade XX	Plasticized Resin Greater % than Grade XP	A paper base laminated material similar to Grade XX in electrical and moisture resisting properties, but more suitable for hot punching. Intermediate between Grade XP and XX in punching and cold flow characteristics.
XXX	Cotton Rag Paper	Hard Greater % of Resin than Grade XX	A paper base laminated material, suitable for radio frequency work, for high humidity applications. Minimum cold flow characteristics.
XXXP	Cotton Rag Paper same as Grade XXX	Plasticized Resin Greater % than Grade XXP	A paper base laminated material, similar to Grade XXX, but with lower dielectric losses and more suitable for hot punching. This grade has greater cold flow than Grade XXX, and is intermediate between Grades XXP and XXX in punching characteristics.

Fabric Base Grades

	BASE	RESIN	CHARACTERISTICS
C	Heavy Weave Fabric	Hard	A fabric base laminated material made throughout from cotton fabric weighing over 4 oz. per square yard and having a count as determined from inspection of the laminated plate of not more than 72 threads per inch in the filler direction, nor more than 140 threads per inch total in both warp and filler directions. A strong, tough material suitable for gears and other applications requiring high impact strength. The heavier the fabric base used the higher will be the impact strength, but the rougher the machined edge; consequently, there may be several subgrades in this class adapted for various sizes of gears and types of mechanical service. Should not be used for electrical applications except for low voltages.
CE	Heavy Weave Fabric	Hard Greater % of Resin than Grade C	A fabric base laminated material of the same fabric weight and thread count as Grade C. For electrical applications requiring greater toughness than Grade XX, or mechanical applications requiring greater resistance to moisture than Grade C. Exceptionally good in moisture resistance.
L	Fine Weave Fabric	Hard	A fine weave fabric base laminated material made throughout from cotton fabric weighing 4 oz. or less per square yard. As determined by inspection of the laminated plate, the minimum thread count per inch in any ply shall be 72 in the filler direction and 140 total in both warp and filler directions. For purposes of identification, the surface sheets shall have a minimum thread count of 80 threads per inch in each of the warp and filler directions. This grade is suitable for small gears and other fine machining applications, particularly in thickness under ½ inch. Not quite as tough as Grade C. Should not be used for electrical applications except for low voltage.
LE	Fine Weave Fabric	Hard Greater % of Resin than Grade L	A fine weave fabric base laminated material of the same fabric weight and thread count as Grade L. For electrical applications requiring greater toughness than Grade XX. Better machining properties and finer appearance than Grade CE—also available in thinner sizes. Exceptionally good in moisture resistance.

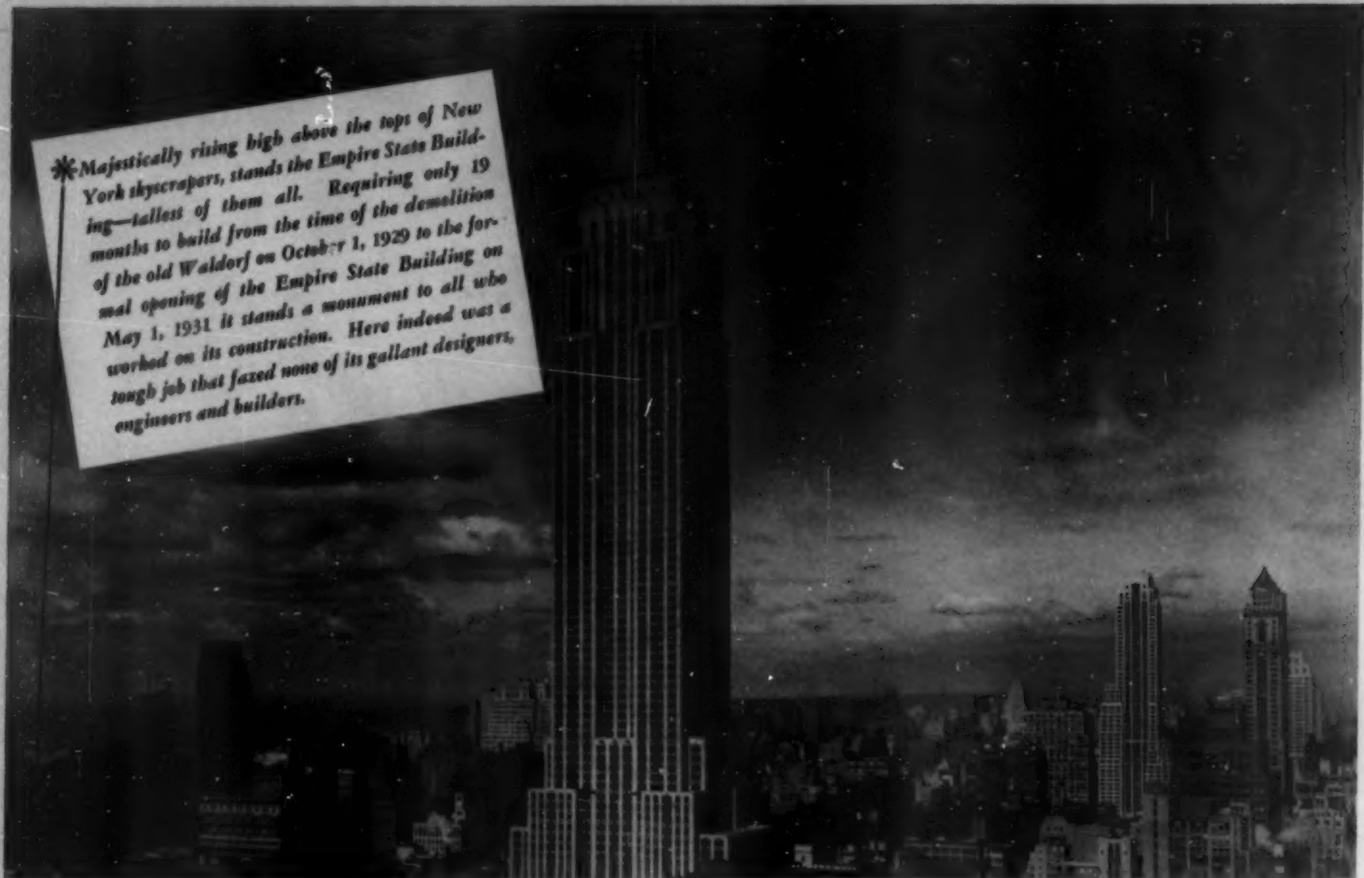
This sheet is one of a series describing the manufacture, grades, properties, and applications for Synthane. Keep it in your Synthane data file or ask us to put you on our mailing list to receive these sheets as they are issued.



SYNTHANE
Bakelite — laminated

SYNTHANE CORPORATION, OAKS, PENNA.

REPRESENTATIVES IN ALL PRINCIPAL CITIES



*TOUGH JOBS DON'T FAZE US.. EITHER

Have you a plastics fabricating job that you are convinced is a tough one? If so, our engineers and chemists may be able to solve it for you . . . just like we've done for others. The tougher the job, the better we like it. But, we never skim over the easy jobs, either. We do them with the same vigor as the tough ones. We'd enjoy the pleasure of serving you.

•

We may be able also, to design plastic materials to take the place of hard-to-get metals. Ask us about it.

Seamless extruded tubing and shapes of Vinylite, Ethyl Cellulose or Cellulose Acetate Plastics, etc.

Sheets, Tubes and Rods of Nitro Cellulose, Cellulose Acetate or Ethyl Cellulose Plastic.

Fullest cooperation will be given to manufacturers with high priority ratings requiring the above materials.

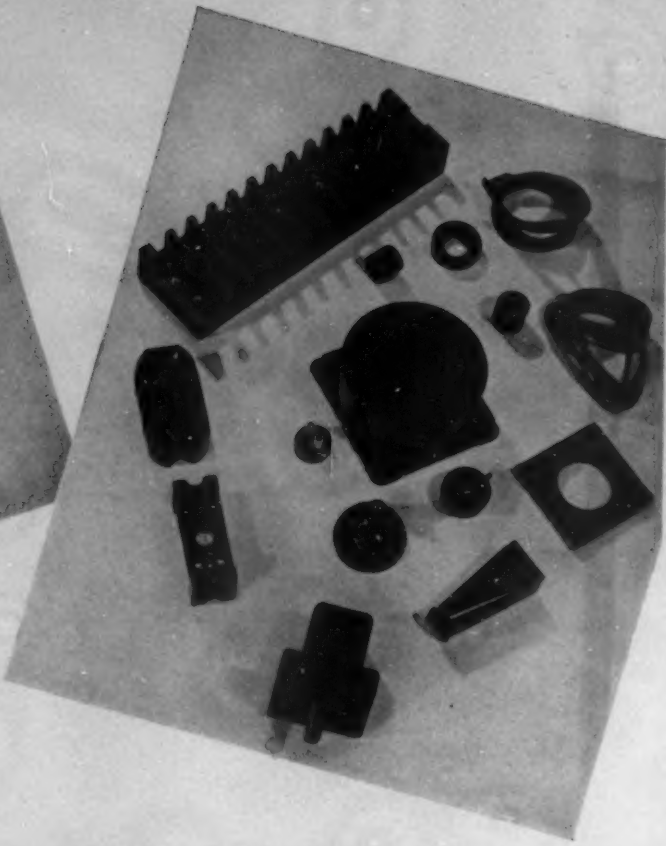
Inquiries invited.

"ETHYL RUBBER"
produced in
TUBES, RODS and SHEETS

INJECTION MOLDED PARTS
EXTRUDED SHAPES
FORMED ARTICLES

THE Insel COMPANY
ARLINGTON, N.J.

HOW PRECISE PLASTIC PARTS CAN SPEED YOUR PRODUCTION



It's unnecessary to tell you manufacturers what part plastics can play in record-breaking production, for you know their advantages full well.

But what should be emphasized is that *precise* plastic parts can greatly speed your output by reducing inspection rejects and by eliminating the need either for "forcing" parts to fit or searching for a part that fits.

Auburn molded plastic parts have been made always to a high standard of accuracy—finishing is thorough, inspection especially keen, handling and packing most carefully done.

While this type of exacting workmanship may seem more expensive initially, actually in the long run it is less because of savings in assembly time and improved quality.

Since 1876 we have been molding to the same high standard for it's the only standard we know how to meet—it's the standard that helps you most.

AUBURN BUTTON WORKS, INC.

ESTABLISHED 1876

AUBURN, NEW YORK

MOLDERS OF ALL TYPES OF PLASTIC MATERIALS BY COMPRESSION, TRANSFER INJECTION AND EXTRUSION METHODS

Melmac's Inertness and Surface Hardness Bring New Utility to Plastics

Superior resistance to moisture absorption...increased resistance to chemical attack, staining and discoloration—these are advantages of MELMAC*. This new melamine-formaldehyde thermosetting plastic developed by American Cyanamid overcomes many of "yesterday's" limitations in enlarging the range of practical plastic applications. And does it, too, with existing facilities of the Plastics Industry.

TYPICAL PROPERTIES: Melmac 1077 (Alpha-filled)

Boiling water absorption (30' boil, 8 oz. tumbler) 0.5-1.2%

Cold water absorption (7 days) 2.5-2.7%

Chemical resistance—no change in appearance after seven weeks immersion in acetone, dioxane ethylene dichloride, zlycerene, 10% citric acid, 10% C.P. caustic, methanol, liquid soap, xylene or tap water.

Boiling water produces no surface attack after prolonged immersion.

TYPICAL APPLICATIONS: Tableware (now limited to Army, Navy, Merchant Marine, Air Forces or other essential needs); buttons of all types; exposed parts, fittings, and controls where resistance to weathering and moisture and/or chemical inertness are required.

Write for further information. Data sheets are available. Melmac Plastics currently require a priority rating for commercial use. Test samples, however, can be supplied without priority for experimental and research work.

AMERICAN CYANAMID COMPANY
PLASTICS DIVISION
30 ROCKEFELLER PLAZA, NEW YORK, N. Y.
*Reg. U.S. Pat. Off.

Melmac
A CYANAMID PLASTIC

MODERN PLASTICS

NOVEMBER 1942 VOLUME 20 NUMBER 3

ALL PHOTOS, COURTESY UNITED PLASTICS CORP.

1—Injection molds for thermosetting material are constructed to handle inserts. This one takes the 12 shown below. At right is the completed shot with runners and sprue

Injection molded thermosetting parts

by A. R. MORSE*

THE injection molding of thermosetting materials in continuous production has long been a fond dream if not a forlorn hope of the plastics processing industry. Now the dream has materialized and the hope is a reality, as demonstrated by the developments and current activities of United Plastics Corp., Cleveland, Ohio, through their use of what is termed "jet molding."

The new process offers a number of advantages to such users of plastics as the electrical, automotive and aeronautical industries, whose requirements call for parts of exceptional density and high, uniform quality to be made available on fast production schedules.

Principal advantages of this injection molding process are as follows:

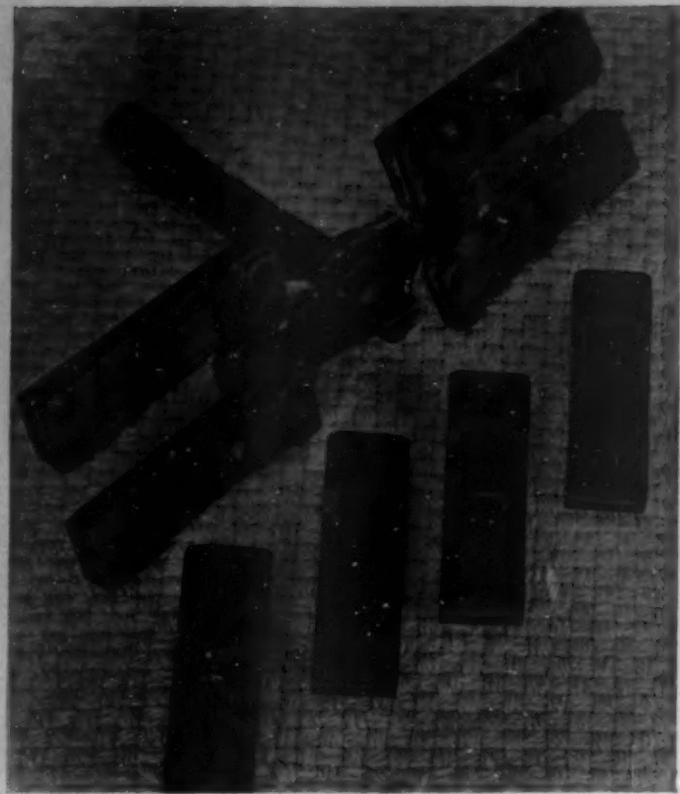
1. Low-cost molds; fewer cavities for comparable production rates; marked saving in metal and manhours of skilled labor.
2. Shortened preparatory interval before starting continuous production.
3. Fast production rates.
4. Ready accommodation of various types of material without changes in the molds.
5. High uniformity of product.
6. Minimum rejects on work involving close tolerances.
7. Special facility in molding parts with inserts.

The basic difference between this and other processes is that all the heat load necessary for polymerization is introduced into the material *prior* to injection. The mold merely shapes and sets the material.

The machines used are standard injection-molding machines, adapted to this process with special conversion units,

* Sales engineer, Reed-Prentice Corp.

2



3

2—Below are two finished pieces of injection molded thermosetting material after they have been broken off the sprue and trimmed. Each carries 6 inserts. *3—Four pieces are molded in this shot. Characterized by high inner density, durable surfaces, they appear below after trimming and tumbling*

the nature and installation of which is discussed in later paragraphs. Because of the fact that this company has used the process here described only for molding thermosetting materials to date, the references in this article are largely confined to those materials. However, this process may be adapted to handling thermoplastic materials, as well as the new heat-sensitive compounds which are currently appearing, simply by changing a heater part.

To make a comparison between production rates of injection and compression molding: a mold of four cavities using the injection process would equal the production rate of a compression mold of sixteen to twenty-four cavities on the same job. Using an equivalent number of mold cavities, the injection process would turn out five or six times the number of pieces produced by compression molding.

It should be noted that the injection process handles all thermosetting materials without further adaption of the machines or molds. Government specified materials are used currently in production for war. When the war is over, and automotive and electrical engineers again turn to designing parts which combine beauty and utility, the variety of materials and colors used will naturally increase. Thermosetting parts molded by continuous injection will surely find their way into the automobiles, refrigerators, radios and other equipment of tomorrow.

The company began experimental production by converting a standard injection molding machine nearly two years ago (October 1940). Commercial production soon followed, and more machines were installed as the demand for these molded products required additional capacity. The persistence and growth of this demand has kept the company on a three-shift production schedule continuously. Meanwhile, increased pressure from users for a growing variety of molded parts and products has rapidly broadened the possibilities of the process of injection molding thermosetting materials.

Characteristics of the parts

Test bars and samples from typical production runs reveal an amazing homogeneity of section not generally found in compression molded pieces. These bars and parts do *not* show a porous, low density interior. It is this porosity, harboring destructive moisture, which can cause compression molded products to crack or fail under extreme temperature conditions found at high altitudes. Airplane parts injected in continuous production are extremely dense and actually appear to be toughened by exposure to temperature extremes that might cause other moldings to fail. Molded parts with intricate inserts are cut apart to demonstrate the exceptional density of the inner section as well as the accurate positioning of the inserts.

Furthermore, the surfaces of injection molded thermosetting parts seem to be more durable because they are solidly backed by the high inner density of the piece. This fact naturally calls the attention of designers and engineers to the use of these moldings in new electrical fields where hard use is the rule and consistent high dielectric properties are essential.

And when requirements are for moldings having both thick and thin sections in the same piece, engineers who specify injection molded phenolics are assured that each rib or section will have the full material strength that is specified in the design. The importance of this homogeneity and extra density cannot be overstressed, especially where plastic parts are called into service to replace stampings, die castings and other metal parts. Nor is the molding cycle materially changed when thick and thin sections are required in the same piece. Thus high production may be maintained at low cost. By

4


5


6


4—Standard injection molding machine converted to handle thermosetting material. *5—Removing the core from an injection molded piece. The removable plug is replaced in the mold for the next shot. Duplicate plugs help to speed production.* *6—Here the operator removes the completed shot from the mold*

other methods, such vari-section moldings would require an increased number of cavities to maintain production schedules.

Because the setting of the material takes place under closely controlled constant mold temperature, the consistent quality of molded parts required to meet exacting dimensional specifications is more easily maintained than where mold temperature must be varied during each cycle.

The process of conversion

Adaptation of standard injection molding machines—Several special features described below have been developed to aid in meeting war production schedules, but the basic machine[1] is exactly like the one regularly supplied to thermoplastic molders. The relative ease with which most standard machines may be rebuilt to use this process cannot be overlooked.

Details of the conversion unit[2]—Typical conversion units consist of a special heater of relatively simple construction with thermocouples for indicating both heater and mold temperatures. A standard transformer with a manual starter and automatic timer or regulator allows the operator to govern the application of intense heat, which plasticizes the material and causes it to flow into the mold under pressure. The adapting unit consists of a conventional feed cylinder and plunger of somewhat smaller diameter than that commonly used with thermoplastics.

[1] Machines manufactured by Reed-Prentice Corp. Models 10A-4 and 10D-8.
[2] This unit and the methods employed are the inventions of Clement D. Shaw, and are held in trust by William B. Hoey and Everett D. McCurdy as trustees. These inventions are covered by patents under which United Plastics Corp. is a licensee. Plastics Processes, Inc., is the licensing agent for these patents.

The heater body screws into a flange on the feed cylinder. The body of the heater is warmed by electric bands, although steam or oil may also be used. The recorded temperatures of the main section of the heater run considerably lower than they do on the conventional thermoplastic setup. While this is due to the fact that less heat is required at this point, it must also be recognized that the thermocouple is nearer the actual material because of the simplified construction of this heater. Thus this recorded temperature more nearly shows the actual state of the material than do similar indicators on usual thermoplastics equipment (*Please turn to page 128*)

Cooperation—industry's job today

It is the sadly recognized truth that thus far the ruthless Nazi war machine has been more efficient in its utilization of materials and facilities for war production than we have. This is not a peculiar phenomenon. Germany has been preparing for this war for more than a decade. The German Government has forced industry into the pattern of war making, has put a heavy penalty on wasting its materials and has brought home to its people the inescapable fact that the appetite of a war machine is insatiable.

Cartelization and combination have been carried on to a degree which this country has not even dreamed of. There are no trade secrets. Operations, methods of production and short cuts are the property of the State, distributed throughout industry so that the lifeblood of the German war machine will continue to flow.

Tradition has aided the Germans in doing this. Since the rise of the German nation, its people have subjugated their rights to the mythical creature called State.

In the United States we have taken the directly opposite tack. Competition—doing something better than the other fellow can do it and keeping your method of doing it better strictly to yourself—has been an axiom of American industrial practice. We have recognized the imperfections of competition. We have recognized that it has many faults, but since competition is the lifeblood of our industrial democracy, we have winked at its faults because its virtues were so great. We have believed that the man with technical know-how was entitled to keep that know-how to himself and gain a monetary reward because he could produce something more efficiently than the other fellow, and thus sell it at a lower cost than anyone else. Even the framers of the Constitution recognized this right by granting a legal monopoly in the form of a patent to an inventor.

Now we are in the throes of the greatest war the world has ever seen. It is a struggle between a group which believes it is a master race and would enslave all others, and a group that believes in the right of each individual to rise, according to his own abilities. It is a struggle where the side using its industrial capacity and raw materials most efficiently will probably win the war.

Our Government has already recognized the necessity for drastic action. It has suspended many patent rights for the duration of this war. It has encouraged and aided in pooling of resources, of materials, of labor and of abilities. It has even devised methods of clearing such arrangements so that they will not run afoul of the laws designed to insure competition—the so-called anti-trust laws.

But there are many who do not think in terms of a battle for our very existence. There are even some few—fortunately a very few—who see this war as a chance to protect their competitive position.

"Why," they ask, "should we give away information for which we have spent thousands of dollars and many years in developing?"

The answer to this need not be wrapped in the jargon of economic planners. It is so simple that it is fundamental. The answer is that business *must* pool its information, it *must* "give away" trade secrets which it has protected for years because unless it does these things voluntarily, the Government will step in and take such rights. The Government knows how vital the solution to this problem is. It knows it is in a battle against the most ruthless horde of demoniacal fanatics since Genghis Khan and Attila the Hun. Frankly, there are those in high places in our Government who are weary of namby-pamby methods in forcing industry to full disclosure, a lack of which may be costing the lives of many thousands of American boys.

With this in mind, the editors of MODERN PLASTICS welcome contributions of responsible members of the industry applying to new methods of operation, new materials that may have been developed for specific purposes, some new operation with an old tool or with an old press—anything, in fact, that will contribute materially to sharing the know-how. This is an opportunity for the plastics industry to share its knowledge, pool its resources and show that it, like the aviation industry, is ready to forget the usual competitive aspects of industry and the idea of doing business as usual. It is a chance for the industry to contribute everything it has to the success of the war effort.

Free men giving up voluntarily the rights for which they have struggled have always regained those rights when the crisis which made their sacrifice necessary passed. But having those same rights seized by the Government is the forerunner of a bitter and violent struggle to regain them.

We still have the choice of free men. To disregard or delay making that choice of full industrial cooperation may mean the death of American industrial enterprise as we know it, and the beginning of a system of State control that will forever bar the return to a free competitive world.

Raymond R. Dickey
Editor

S. P. I. FALL CONVENTION

HIGHLIGHT of a two-day SPI wartime convention held October 12 and 13 at the Westchester Country Club, Rye, New York, was a speech by Frank Carman, Chief of the Plastics and Synthetic Rubber Section of the War Production Board. Mr. Carman went into the entire supply situation of plastic materials, gave an exact outline of how they stood and discussed the future for each material.

Mr. Carman then explained in detail the workings of an order which will probably be issued soon and which will control end use of phenolic plastics much more closely. His discussion was the clearest explanation of the rôle and status of the plastics industry that has come from Washington in a long time. Text of the speech follows:

Your program committee has asked me to speak briefly on the current situation surrounding the plastics industry and to touch upon the probable outlook for its future. Please understand that I have no power to give directions or authorizations on War Production Board operations regarding orders that may be promulgated in the future. This is vested only in the Director General for Operations.

The Chemicals Branch of the War Production Board is charged with the responsibility of handling all problems in connection with resins for the war effort, and must of course, be concerned not only with the distribution of the available supply but also with the provision of new supplies to make certain that war requirements and essential civilian needs are satisfied. Since the resins as a general topic fall into two main classes, I would like to discuss the thermoplastic materials and then follow with the thermosetting grades, which are of considerable interest at the time.

Cellulose plastics. The cellulose acetate plastics are now controlled by mandatory order M-154, which has been operating fairly satisfactorily in respect to this class. It has been reported that this material is in relatively free supply and that Class III uses can be supplied in full. There is some indication that business has substantially diminished for other reasons; it might be well to point out that plasticizers are not in free supply at this time and Class III uses under the M-154 Order may not continue to be satisfied in full for this reason.

Production of cellulose acetate butyrate has increased somewhat during the last few months, and it is estimated that supplies are sufficient to meet all military and civilian uses now allowed under the existing order.

Allocations of cellulose nitrate raw materials for the month of October have been reduced to the point where only a portion of Class II products in order M-154 will be supplied. The reasons for this shortage are that the plastics industry requires a special grade of nitrocellulose and, in addition, the capacity cannot be increased because of the curtailments necessitated by large war demands on the ammonia supply. Even though production of ammonia is being materially increased, the demand for other more important war products will not allow further diversion to this plastic. Therefore, the shortage of ammonia, the allocation of nitrocellulose (because of acute short supply situation) and the increasingly large demands for solvents and plasticizers will tend to decrease the production of less essential items in cellulose nitrate plastics.

Methyl methacrylate resins. The monomer is being currently produced by two chemical companies and the bulk of the production is now being used for cast sheets for military aircraft. In this form, it is used for bomber noses, turret tops, domes, and other special equipment. A limited amount is being used for molding powder, waterproofing of certain military jackets, and special chemical warfare items. There are definite limitations on the amount of aircraft sheeting that can be produced. However, plans are going forward for an expansion of monomer capacity to about 141 percent of the present production and in the cast sheet capacity to about 180 percent of the present production. The limitations on expansion of methyl methacrylate resins are mainly in the equipment field, since large amounts of stainless steel are required. The supply of this resin for all civilian uses, with the possible exception of dentures, has disappeared entirely. All of the current production is required for direct military uses. It is quite possible that full allocation of acrylate resins will be necessary in the immediate future, and that the casting capacity will likewise be allocated to insure fulfillment of the most necessary direct war products. The expansions now under way will not be completed and in production before September 1943, therefore no relief is expected during the next year.

A valuable contribution to the war effort can be made by all of you by advising and directing the use of less critical resins in some of the marginal or less essential items where acrylates are currently specified or used.

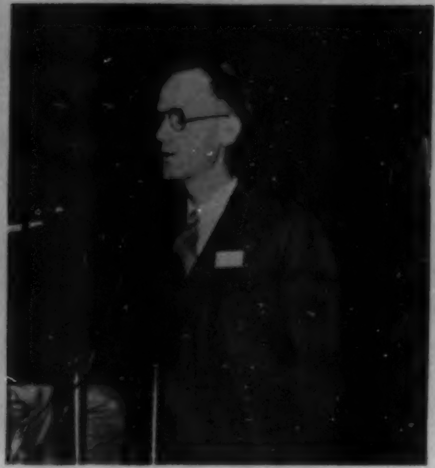
Vinyl polymers. Polyvinyl chloride and vinyl chloride copolymers are the most important of the vinyl group in the war effort. Large quantities of these resins are currently being used to replace rubber and even in many products where rubber is not satisfactory. It is estimated that approximately twelve million pounds of these resins were used as rubber substitutes

FRANK CARMAN

LIEUT. COMDR. M. B. MERRITT

GUS HOLMGREN

H. W. HUEGY



DR. GORDON M. KLINE

E. T. STERNE

during the first six months of this year and the resulting saving in rubber might be conservatively estimated at eighteeen million pounds. The production of these resins in the United States can be divided roughly into two classes: one covers polymers containing 92 percent and more vinyl chloride, and the other those with less than 92 percent vinyl chloride. The production capacity of the high molecular weight resins (over 92 percent vinyl chloride) will reach an annual rate well in excess of 25 million pounds per year in the very near future.

The principal direct war uses for this grade of resin are generally known in the industry: namely, wire and cable insulation for shipboard use, special sheetings for aircraft accessories and certain tank linings where the lower molecular weight resin material is not satisfactory.

The direct war uses for lower molecular weight resin have been materially expanded during the past several months, and it was necessary to include this grade in the allocation order during May of this year. The principal uses are for the conventional rigid sheets for aircraft windshield and cockpit covers, plotters, and computers; proofed goods, including Army raincoats, special plane paulins and engine covers, field bags, hospital sheeting, and other Army and Navy items. The material is also being used in certain chemical tank linings, special protective paints and paper coatings. Only the most essential civilian products are currently being allowed, and it is the opinion that war products will require increasing amounts in coming months.

There are definite limitations on the expansion that can be made in the manufacturing capacity for vinyl resins, as large amounts of acetylene and chlorine are required as the principal raw materials, and the reactions must be handled in stainless steel equipment. Likewise, an increased tonnage of resin will require a corresponding increase in plasticizer in order to make the resin useful as a rubber substitute.

Vinyl acetate and polyvinyl acetate. This material is used not only in an intermediate stage for the manufacture of polyvinyl alcohol, polyvinyl acetals and vinyl chloride copolymers, but has recently become a commercially important resin in its own right, where it is generally used in the form of polyvinyl acetate water emulsions or alcohol solutions. There are two major producers of vinyl acetate monomer, and even though these companies are running at capacity the current production will not begin to take care of all the important war uses, which include the production of sulfa drugs as well as the polymers already mentioned. These products have become increasingly important, as they can be used as rubber substitutes, and many new military and civilian uses have developed in the last 6 months.

One of the essential uses of vinyl acetate is in the manufacture of sulfa drugs and approximately 7.0 percent of the current production must be diverted to that purpose.

A large amount of vinyl acetate is being used in the manufacture of vinyl chloride copolymers already discussed. It is estimated that 14 percent of the available material is being used in this production and this will probably be continued unless some unforeseen requirements develop.

There are four major producers of polyvinyl acetate either in emulsion or alcohol solution. These are currently being used for adhesives in the bonding of textiles, paper, cork, leather, etc., usually by heat sealing; they are also used in the manufacture of printing inks, textile-sizing, show adhesives and special coatings. Recent large demands have come in for use of these resins for special sealing compounds, for food packages, shoe cements and shoe impregnating compounds and ammunition boxes on direct war contracts. There is not enough raw material for the producers to run to capacity, and thus only high-rated, direct war products can be supplied.

There are three principal producers of straight polyvinyl acetate resins, which are used mainly for adhesives. It is expected that production will be reduced very materially because of the raw material shortage.

Polyvinyl alcohol, a large consumer of vinyl acetate, enters into the production of direct war products such as special linings, solvent-resisting tubing, textile finishes, paper specialties, and film. There are several potential war items which may require a large volume of this resin, and there is no indication that the material can go into civilian items in the immediate future.

Vinyl acetate is the principal raw material used for the manufacture of the acetal resins such as Formvar, Butvar, Butacite and Vinylite X. The bulk of vinyl butyral was formerly used as the plastic in safety-glass manufacture. Even though this use has been greatly reduced because of the decline in civilian automotive production, there is now a large demand for this resin for the manufacture of several war products. There are three major producers of this grade of resin at present. The acetals are produced from the acetate monomer by polymerization, conversion of the polymer thus produced into polyvinyl alcohol, and condensing this in turn with the corresponding aldehyde. The condensation products are rubberlike, plastic and elastic, or hard and brittle resins depending upon the aldehyde used. The two most widely produced resins are the polyvinyl formal and polyvinyl butyral. The latter resin is currently being plasticized and compounded on conventional rubber equipment for the fabrication of raincoats and similar war products. Some of the other major uses for the acetals are special wood impregnates, wire insulation, fuel tank liners, army fabrics of all types, gas masks, shatter-proof glass, protective cover, clothing and laminating cement for sealing special envelopes and packages. Approximately 43 percent of the present vinyl acetate production is being diverted to the production of the acetal resins.

The main restriction on larger production is the supply of acetate monomer. It is estimated that the present requirements for acetate monomer are now about 131 per cent of the produc-

tion capacity, and this will rise to 200 percent by March 1943 because of direct war requirements. As already indicated, an expansion in monomer capacity is underway and it appears that we will have facilities available by the middle of 1943 in an amount equal to 180 percent of the present production capacity.

To insure the use and delivery of vinyl acetate monomer to the most important war uses, it has been necessary to place this material under full allocation, and to effect this, General Preference Order 240 was issued October 8, 1942. This calls for deliveries by the two producers only as directed by the Director General for Operations. It will be a relatively simple order to administer in that the material will be delivered to only a few prime consumers, including six drug manufacturers. Forms PD-200 and PD-601 completed by the applicant and producer, respectively, are the only reports required by the WPB.

In addition to the vinyl acetate order, all vinyl resin polymers have been placed under complete allocation through a new amendment to General Preference Order M-10, effective October 10. This order originally covered the complete allocation of only the polyvinyl chloride resins, but it has been deemed necessary to put all the vinyl resin polymers under this same mandatory control, as there is not sufficient material to satisfy even the direct military demands at this time.

The order restricts use and delivery except as authorized by the Director General for Operations. One of the major changes effected by the new amendment will be the restrictions on the use of scrap which from now on may not be used except for the purposes as authorized. Allocations will be made to the most essential end uses and applicants will report requirements to the War Production Board on Form PD-36 as before. It is imperative that the end use function be clearly defined in these reports, otherwise there may be considerable delay in authorizations for many essential products. A transmittal letter giving full instructions for resin applications will be sent each applicant.

Polystyrene. As already indicated in the press, the synthetic rubber program calls for considerable expansion in the styrene production facilities for the manufacture of Buna S. It has been previously announced that approximately 200,000 tons of monomer styrene will be produced in seven plants. It is possible that a slight excess of this material will be available for the manufacture of polystyrene resin, and this, of course, will be available for certain war products. Production of polymer in October will be at least as large as that of previous months and this will be used mainly in direct war and essential civilian products. It is believed that the only future uses of polystyrene that can be allowed will be similar essential items including electrical insulation, special coating requirements, and instances where the material is a substitute for rubber. It naturally follows that the latter diversion of styrene can only be effected when there is a surplus of monomer from the general rubber program.

Thermosetting resins—urea formaldehyde. The distribution of urea formaldehyde and melamine formaldehyde materials is currently being controlled by General Preference Order M-25. Both are adequate in supply to take care of military and essential civilian needs. However, the growing demands on ammonia for other strategic military products might conceivably cause a further reduction in the availability of urea for some of the less essential civilian applications. There is a growing demand for the melamine resins which now indicates this grade might possibly be restricted to necessary military items in the insulation field. If you know of any potentially large requirements for melamine resins, it is suggested that these be called to the attention of the War Production Board Chemicals Branch before major steps are taken for such uses.

Phenolic resins. The uses of this versatile class of resins are widespread and most of those present are more familiar with the material than the speaker. It is estimated that there are sixty-six producers of phenolic resins, some of them for their own consumption, and 1775 users. As you have probably learned by this time, it has been necessary to restrict the uses of phenolic resins to the more important war products because of the shortage of phenol. During the month of September 1942 approximately 48 percent of the total phenol production was diverted to resin manufacture; of the total demands for phenolic resins for that same month, only 60 percent were satisfied. As a further clarification, it appears that only those items having a priority rating of A-1-k or better were handled during that period. This does not include the resins made from the cresols and cresylic acids, which amount to a substantial quantity in the same field. Extensive expansions are being made in the phenol manufacturing capacity and it is expected that the rate of production during the latter part of 1943 will be 175 percent of the current rate. There is little need to discuss the many applications of phenolic resins and their place in the war effort. It is expected that the 1943 demand rate for phenolic resins will be 120 percent of the present overall requirement, and as already indicated this is being satisfied to the extent of only 60 percent.

The only control on the use of phenolic resins has been the General Preference Order M-25, and it appears that the large war requirements, completely eliminating many of the essential civilian items, and the general change in rating structure have materially restricted the normal flow of these resins to industry. Therefore, the only fair and equitable remedy will be complete allocation to end use. It is proposed to issue an order placing phenolic resin and phenolic resin molding compounds under complete allocation by prohibiting delivery, acceptance of delivery or use of these materials without specific authorization of the Director General for Operations. It is not the intention of the War Production Board to burden industry any more than necessary to insure the full and even flow of these materials for the best interests of the war effort. Present thinking on the operation of this order is along the following lines:

1. The user of phenolic resin products such as laminates, plywood, protective coatings, molded products or miscellaneous items will certify the end use to the resin manufacturer. This certification will be accepted by the resin manufacturer and in turn used for reporting the end use to the WPB. Such certification need only be supplied with each order even though it may run for several months. You can materially aid this control by educating your customers to give the proper end use certification and let them know you do not have to make shipments unless this is done.

2. The applicant desiring to purchase phenolic resin or phenolic molding compound will report this end use to the WPB on Form PD-600, stating therein the amount of material he desires to use during the coming period.

3. It is planned to allocate resin and molding compounds to
   a) End uses and for orders on hand as reported.
   b) Anticipated end uses in the amount indicated by the applicant.
   c) Inventory. This allocation is for the convenience of handling rush orders, but the applicant must obtain interim allocations to specific end uses before the material is used.

4. For the purpose of reporting resin and molding powder requirements, it is suggested that items requiring more than 5000 pounds each be reported separately. Further, the applicant may "basket" orders for a similar end use, and he may employ this procedure as he sees fit, as it will be squarely up to him to get the end use information across to the WPB. For example, it is believed that an end use listing under a classification such as "Army aircraft electrical insulation" could be used to cover a group of items including not only insulation employed in the radio equipment, but such other items as the ignition, insulation of landing lights and the wiring of the fuselage. "Army aircraft," "aircraft" or "insulation" alone will not be satisfactory.

Another classification could be "Army aircraft instruments and control parts," which would include pulleys, fairleads, cable guides, instrument cases and panels, control knobs and perhaps bomb sight parts. It is obvious that electrical insulating parts of instruments might properly be placed in either of these classifications, but as long as your report is in one or the other but not in both, the objective of this report will be attained. As a

further example, a suggested classification could be reported as "shipboard electrical insulation" to cover a group of detailed or specific end uses even larger than those already cited. In grouping of parts into one classification, please try to be guided by similarity of "functions," which in turn depends upon the prime characteristics of the basic material.

By and large, phenolic resins and their products find their most valid uses where proper advantage is taken of a combination of their fundamental properties. This use may be differentiated from many applications which we are tempted to make in these times where the only justification for the item is merely an out and out substitute for another critical material. To illustrate, a molded laminated antenna mast is a valid end use because it combines structural strength, lightness of weight, and electrical insulating properties together with resistance to weather. On the other hand, a piece of laminated phenolic employed as a portion of the skin of an airplane merely in order to save an equivalent bulk of aluminum may very well be a less urgent use in the light of any given relative supply picture. Therefore, we would not agree to the "basketing" of these two parts under the broad heading of "aircraft members." We do not want vague end use listings such as "industrial equipment" or "oil well equipment." If the use in such case is known to be, for example, "motor pinions," then so state it. Here again, "industrial equipment" should be broken down to a further classification such as "electrical insulation" or "structural members," keeping in mind the end use function of the part that it will supply to the final application. Generally speaking, these materials have the following outstanding properties: good electrical insulation, chemical inertness, ease of fabrication, good mechanical strength, and lightness of weight. In most instances a valid choice of phenolic plastic as the material of engineering to be used will have been based on two or more of these characteristics.

By contrast, a usage of phenolic plastics based solely on conserving an equivalent bulk of some other critical material is a relatively invalid use. Thus, in grouping the information which comes to you from your customers and reporting to the WPB, you must be careful not to in any way distort the actual and final function of the material in your customers' use. If any question is in your mind in the case of any given application, repeat the exact end use listing as certified to you. As a further suggestion, we would welcome the submission of suggested end uses in groups which any applicant desires to send to the War Production Board before the order may have become effective. We will gladly make comments and suggest changes when desirable for efficient handling.

5. In the event of bulk sales of material either to your customers, who fabricate for their own use, or commercial sale, a listing of intended end uses must be obtained from those customers in their certification to you. The order will clearly state that the material must be used for that particular end use originally certified to you and for which it was allocated, and any diversion of this to other end uses can only be made after specific authorization as provided therein. It is suggested that you acquaint your customers with this provision of this order.

6. The applicant may apply weekly or at any time for allocations to use inventory for specific end use if it is not possible to handle such orders on a monthly basis.

7. It is the intention and policy of the War Production Board to allow the production of all the essential war items requiring phenolic resins, and we will do everything possible to make the phenol available for this purpose. Knowing that the material is going into valid end uses will materially insure and allow the continuous manufacture of these products.

8. Those reponsible for these controls are cognizant of the industry's desires and need for all possible information on allocation policy and the supply situation of critical material, so that permitted end uses may be known with some degree of certainty. This is most important in connection with engineering of new products and equipment construction. It is planned to keep you informed of the various end uses which are currently being supplied, and if there are any questions as to the possibility of a certain material being allocated to a new item, it is suggested that you contact the proper section of the Chemicals Branch.

Please understand that we want to make the operation of this order as easy as possible for industry. It is recognized that the control as currently contemplated will largely serve to filter the good existing uses from these which are unjustifiable at this time. In connection with the contemplated new uses, we recognize that the control exercised by such an order may occur at an inopportune time with respect to the procedure involved in designing new war implements as well as substitutions. Therefore, please urge your customers to acquaint you or the War Production Board with new and large uses which may develop into important requirements for phenolic resins.

In summing up, I would like to state that the thermoplastics such as the acrylates, polystyrene and vinyl polymers are in short supply, and it appears that the future uses must be confined mainly to war products. Cellulose acetate and nitrate are relatively free at the moment for the more essential items. Raw materials supply may cause further restrictions in the future.

The ureas are in fair supply and full allocation does not appear to be necessary for the present. Phenolic resins must be further restricted because of the growing war demands and the shortage of phenol.

It is hoped that the proposed new orders mentioned here will be beneficial in directing the flow of the critical resins to the most important war products. As resins manufacturers and users, you gentlemen can materially aid the war effort by guiding the various users of these resins to the proper choice of the most available materials and by substituting the less critical grades wherever possible. Also, it is generally conceded that many thermoplastic processors are not running to capacity on war products while others have more orders than can be handled. With the coming shortage in many of these materials, it is becoming increasingly evident there will be further curtailment in the less essential products, and those manufacturers not on war work will have their operations further restricted. The War Production Board cannot honestly give priority assistance to the expansion of manufacturing facilities when it is known that many of the operators have available equipment. It naturally follows that there is a growing need for subcontracting in this branch of the industry, and we believe this is a problem that all of you should give careful consideration. The Armed Services together with the War Production Board will do everything possible to aid the plastics industry in spreading this work. If you know where such subcontracting can be done effectively, please call on Washington for this assistance. The challenge is left with you that this is a *job* for *all of us*, not just the Armed Services and the War Production Board.

Materials conservation

Lt. Comdr. M. B. Merritt of the Navy's Conservation Section explained that all Navy activities on conservation had been consolidated under O. W. Dexter. The function of this consolidated conservation division is to coordinate activities of the Army, Navy, United Nations, Federal Departments and industry in efficient utilization of critical materials. Defining the purpose of conservation as a method of directing critical materials to most essential uses, the Commander revealed that there is a conservation man on the requisition desk of practically every Bureau of the Navy, checking specifications to see whether this purpose is carried out. He told the molders, laminators and fabricators who have no naval contacts to approach the Navy through the Conservation Section, and "we will take you through the ropes and arrange methods of testing your ideas."

Mold obsolescence

A method of scrapping obsolete molds was brought into discussion by Gus Holmgren, Bureau of Industrial Conservation, War Production Board. Mr. Holmgren suggested an order similar to the printing-

plate order which requires printers to scrap old plates, and said that a five-year period of non-usage had been suggested as a test of obsolescence. He asked for thoughts from the floor as to how the War Production Board could best put such an order into effect. In answer to a question, Mr. Holmgren explained that if the molds are being used it does not matter how old they are; WPB will still not want to order them scrapped. Various suggestions were made from the floor, and Mr. Holmgren finally stated that it would probably be a good idea to get the reaction of the industry through letters written to the WPB.

Price control A discussion of the theory and necessity of price control was given by H. W. Huegy of the Office of Price Administration, substituting for W. A. Neiswenger of OPA, who was unable to attend the convention due to a last-minute change in plans. Mr. Huegy said that the plastics industry could help OPA in controlling prices, since the use of plastics makes more goods available for civilian consumption, thus relieving to some extent the pressure of buyers in competing for unavailable goods, which runs up prices. He explained briefly a plan which would allow producers (such as the plastics industry) making specialities to set their own price ceilings by using the same estimating methods that they used in the past, thus arriving at the same prices as they would have in the past. He said this was the honor system method. In closing, he emphasized that the best method of staying in business at a profit under a price ceiling was efficient operating methods.

British plastics in war Dr. Gordon M. Kline spoke of his recent trip to England, where he consulted with British officials on the utilization of plastics in that country. He traced the setup of the British Government in procurement and supply and said that definite progress is being made in England in the application of plastics to aircraft. This program, according to Dr. Kline, is based on three principal purposes: first, the necessity for finding substitutes for imported materials; second, uses of plastics to enlarge the available labor supply; third, simplification of production procedures.

He said that the British had made considerable progress in the use of self-sealing fuel tanks and disposable reserve supply tanks. Another important field for plastics in Great Britain is in the fabrication of propellers, using resin as a bonding agent. He said that he believes this development has a definite future in the American plastics industry. One of the reasons for the growth in England of propeller manufacture from plastic bonded materials is that broken blades can be repaired very easily.

Large amounts of paper laminated and molded materials are going into miscellaneous parts, Dr. Kline revealed.

Canadian controls E. T. Sterne, Administrator of Chemicals, Canadian Wartime Prices and Trade Board, outlined price control in Canada and the problems of man-power. Canadian controls parallel those of the United States, Mr. Sterne stated, and there is close cooperation between the two countries in these matters. In Canada there has been a very fine spirit so far as industry is concerned, according to Mr. Sterne, and the controls have worked well. As an example, he revealed that between April 1 and November 1, 1941, the Canadian cost of living index rose a little over 7 percent. After price controls were applied, in November of 1941, the rise between November 1, 1941, and August 1, 1942—a period of greater war activity—was only a little over 1 percent. However, Mr. Sterne stated flatly, a war cannot be won without casualties and that is true on the business front as well as on the fighting front.

Reason for convention Ronald Kinnear, President of SPI, detailed the reasons for having a convention at this critical period. He stated it was necessary for members of the industry to come together in order to revise and bring technical data up to date, to present and go forward with new techniques and to have a general exchange of information if they were to do their utmost in producing for war.

Navy honors SPI Lt. Comdr. Ralph O. Phillips, U.S.N.R., told of the creation of a new Plastics Section of the Bureau of Ordnance, Navy Department, which is to be under his direction. The Commander read a letter from Under Secretary of the Navy James Forrestal. The letter follows:

October 9, 1942

My dear Mr. Kinnear:

In April of this year, the armed forces of the United States were faced with a shortage of rubber and aluminum which threatened the production of several hundred thousand pairs of binoculars vitally needed in the Service.*

A direct appeal for assistance in this critical situation was made through you to the Society of the Plastics Industry. The response was more than gratifying; it established something of a record for prompt and effective action.

After thirty days of intensive activity, your technical committee, appointed specifically for this purpose, was able to submit samples of materials to substitute for rubber, and these have since been adopted as standard by the United States Navy.

I am informed that, as a result of a parallel effort initiated by you at the same time, we may soon be relieved of complete dependence on aluminum for the manufacture of binoculars.

These noteworthy achievements represent not only a generous contribution of time and technical knowledge,

* See Modern Plastics *20*, 50 (October 1942) for a story on the new Navy binoculars.


RONALD KINNEAR


BRIG. GEN. WILLIAM H. HARRISON


LIEUT. COMDR. RALPH O. PHILLIPS

C. N. SPRANKLE

W. H. HOWARD

WILLIAM T. CRUSE

but complete subordination of normal competitive interests to the common cause.

For this fine accomplishment I extend to you the Navy's thanks and congratulations. It is our confident hope that we may look to you for further contributions in the future.

Sincerely yours,
JAMES FORRESTAL
Under Secretary of the Navy

In emphasizing the importance of the plastics industry to the war effort, Commander Phillips cited the speech of Lord Halifax on the Axis' growing control of strategic materials. He quoted the British Ambassador as saying, "In 1939, the Axis Powers had no rubber, apart from their accumulated stocks and the synthetic product; today they have 91 percent of the world's supply. They had 25 percent of the bauxite; they now have 66 percent. They had 7 percent of the world's iron ore; they now have 44 percent. They had 10 percent of manganese ore; they now have 35 percent. They had 9 percent of the tin ore; they now have 73 percent. They had 8 percent of the lead ore; they now have 21 percent. They had 6 percent of the world's flax; they now have 36 percent.

"These are bad figures. To some extent they are offset by our control of most of the materials which the enemy has not got, and by the lead we still retain in such commodities as nickel.

"But these figures are a warning to reconsider our rooted conviction that time is necessarily on our side. It may be on our side, if we face these ugly facts and apply ourselves more seriously than we have yet done to organize our own sources of supply."

The Commander closed with a plea to increase output and continue the "magnificent support" that the industry has given to the armed forces.

General praises industry Principal speaker at the Banquet Session was Brigadier General William H. Harrison, U. S. Army. General Harrison expressed the War Department's appreciation for "the effective and far-sighted work your industry is doing in behalf of the war effort.

"I don't pose as a plastics expert—far from it. As a matter of fact, I know very little about the magic of the trade. On the other hand, because of close association with end products throughout all War Department agencies, I do know of the extent to which plastics are used and, in particular, of the extent to which your research, development and ingenious manufacturing processes have opened up a whole new material field which is providing substantial relief to basic old line materials and manufacturing processes. . . .

"As is proper and natural, we glory in the feats of men in combat. In contrast, there is little opportunity or occasion to pay tribute to those who conceive much of the wherewithal that may make for their success or failure. But you may be assured the Signal Corps knows what you are doing for them; that Ordnance, Engineers, Chemical, Medical Corps, Air Corps and Quartermaster all know."

General Harrison then traced the need for materials and the feats which our armed forces are performing when they get the goods. But he sounded a word of caution.

"To our regret, chagrin—yes, even discredit," he warned, "the record is clear the odds are still against them, and in favor of the other fellow, insofar as the matériel of combat is concerned. . . .

"The drag anchor is shortage of critical materials. Plants are being curtailed in production because these materials are unavailable. I'm not at liberty to give you figures as to how serious this is.

"But knowing how serious it is—and knowing of what you are doing in the field of substituting plastics where old line materials have heretofore been used—I urge each of you to continue to do all in your power along this line. . . .

"In all seriousness, gentlemen, your resourcefulness, your skill, your brains, are needed by your country now as they have never been needed before. New ways—new products—new substitutes for critical materials—new improvements over old ones—that is your job and that is your duty. Don't let all the routines, all the governmental regulations, all the prejudices in the world deter you from originating, creating and driving through to production the crystallized ideas you know will help.

"That's your part and this is your war—as much as it is the lad's who is lying out tonight in the jungle, on an Arctic outpost, or who is reaching frantically for a landing field or flight deck that might not be there.

"In my mind, the work you do is akin to your Army's new-born Glider Command, not because of plastics in the construction of the gliders themselves, but rather because gliders symbolize in their newness—in the day-to-day discovery of their power and future potentialities—man's inner drive and urge to soar by his determination alone into the realms of the unknown, the urge to leave below all that is earthbound by the limitation that 'It's never been done before.'

"In your mind's fancy," General Harrison concluded, "arm your glider well."

Plastics exhibits Two plastics exhibits are to be put on in the early part of 1943, one by Sears, Roebuck and one by R. H. Macy & Co. it was revealed at the convention. C. N. Sprankle, Sears, Roebuck, told the convention that his company wanted to plan an exhibit that would get the company's buyers out of thinking in terms of tradenames and knick-knacks so far as plastics are concerned.

In order to do this, Mr. Sprankle said, the buyers would have to feel and see the materials in finished form and he asked for suggestions from the industry and samples (*Please turn to page 116*)

Molding an airtight meter

AS important as offensive weapons of war for the soldier on the battlefront are defensive weapons against industrial hazards for the men on the industrial front. On both fronts, the function of suitable plastic materials is assuming ever-widening importance. A recent development of interest takes the shape of a new universal type gas mask which affords protection against noxious gases having no warning properties. These are gases such as carbon monoxide and similar toxic agents which, because they are odorless, tasteless and colorless, may permeate the atmosphere without betraying their deadly presence. This type of mask will provide protection against such gases for a fixed interval of time. At the expiration of the safe period, a mechanical device which is attached to the mask indicates to the wearer that contents of the canister which protects against the gas are exhausted.

This function is performed by a molded phenolic inhalation meter affixed to the outlet of the canister. The operation principle is quite simple. A small fan is turned by the passage of inhaled air, and the movement is transmitted to a luminous dial on top of the case. The dial is calibrated in 30-minute intervals, and one complete revolution of the dial corresponds to two hours' average use. At the conclusion of the two-hour period, the canister must be replenished or replaced. The meter's action varies directly with quantity of air inhaled.

This small unit, whose function is such a significant one, represents a triumph of successful molding, achieved in the face of a chain of difficulties. One of the earliest problems encountered was to get the (*Please turn to page 120*)

***1**—This industrial gas mask protects its wearer against such indetectable gases as carbon monoxide by means of the molded phenolic timing meter attached at lower end of hose. **2**—Body of the meter is molded in one piece in a single-cavity mold. Mold for covers and rings has 4 cavities. **3**—Inside dimensions are held to .002 in. to accommodate accurately the minute mechanism. **4**—Luminous dial warns wearer that canister must be replaced*

PHOTO, COURTESY WILLSON PRODUCTS, INC.

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Transparent pipes for beer

PHOTOS, COURTESY TENNESSEE EASTMAN CORP.

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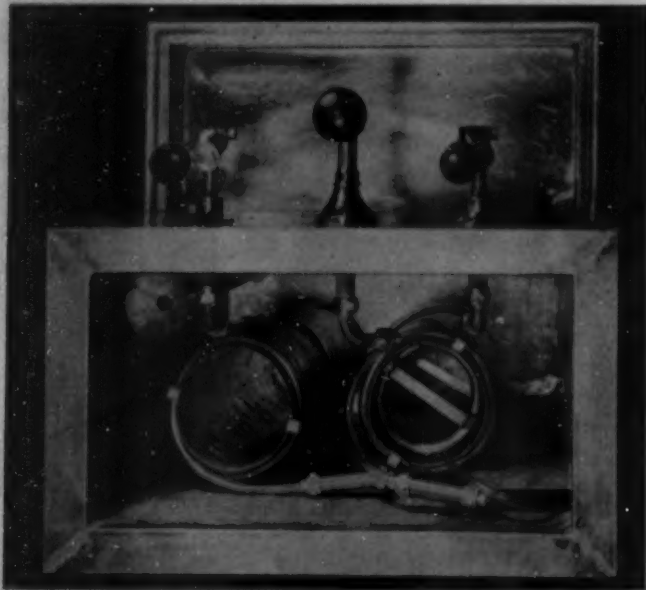

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IT may be that the next time your waiter calls "Draw one," your schooner of beer will come to you via a plastic pipeline. Made of extruded, transparent cellulose acetate butyrate, which is replacing block tin in this type of application, these beer pipes are being manufactured in regulation sizes suitable for use with standard beverage dispensing equipment. The modern establishment boasts a plastic pipe system which carries the beer from the kegs, through the cooling system, to the tap in the bar. Beer thus conducted through a gleaming plastic pipeline is described by the distributor as a draft worthy of the brewer, for it reaches the ultimate consumer with all of the body, flavor, color and head with which it was originally endowed in the brewery.

The transparent properties of the material permit immediate detection of any obstruction or impurity that might clog the line from barrel to tap, to retard the flow or threaten the quality of the beverage. The inside surface of the pipe is as smooth and clear as the most perfectly sanded glass, and more uniform, it is claimed, than any beer pipe previously developed. Customary cleaning devices keep the plastic pipe sanitary.

Extruded cellulose acetate butyrate may be readily bent, formed, coiled or curved, and spiral or flat coils of this material are replacing block tin in commercial ice-cooling systems. It is also adaptable to the direct draw system for use with automatic refrigeration. Tap rods from this same plastic material are also being used to carry the beer from the barrel to the faucet. Cellulose acetate butyrate rods may be threaded with ordinary thread-cutting tools or adjusted to standard flared fittings, so that no time is lost in complex adjustments when this type of equipment is installed in established restaurants.

The plastic pipe is extruded in continuous seamless lengths, and comes both in long coils and in 12-ft straight lengths. Outside diameters vary from $^3/_{16}$ in. to $1^1/_2$ inches. This tough plastic material, with its high degree of mechanical strength and its relatively low moisture absorption properties, is a highly suitable one for this type of application. It is superior in its resistance to weathering and warping, and will resist distortion and deformation under a wide range of varying temperature and humidity conditions. Although presently used in the beverage dispensing industries, the record of performance, as reported by users of these plastic pipes, indicates an expanded field of usefulness for this material in related industries before long. However, at this writing this plastic material is making a double-barreled contribution to the war effort by helping to release important metals and to boost civilian morale.

Credits—Material: Tenite II. Extruded by Extruded Plastics, Inc. Distributed by North Penn Co. under the trade name "Pennco"

1—Pipes of cellulose acetate butyrate have been adopted by leading restaurants to carry beer from the kegs, through the cooling systems to the taps in the bar dispensers. 2—The same material is replacing block tin for cooling coils in draft-beer dispensing apparatus. 3—Transparent tap rods of this plastic material, adjustable to standard flared fittings, are now being used to carry beer from barrel to faucet

Triumph IN A HELMET

PHOTOS, COURTESY INLAND MFG. CO.

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IN plastics molding, M-1 is a name to conjure with. It represents probably the largest direct Government contract ever placed with the plastics industry for a molded part and, at the same time, a new application of plastics in the war effort. Say "M-1" to a molder and he thinks of the helmet liner—the high pressure helmet liner which has been adopted for combat service by the Army.*

Material was the first problem which had to be solved. Material manufacturers' engineers worked in the molders' plants and in their own laboratories to set formulations that would offer the properties, in molded form, demanded by the specifications of the Quartermaster Corps and, at the same time, fit the production processes of the "Z" molders who share the huge task of turning out the liners.

A problem of equivalent proportions was the formulation of a finishing resin which would be dull, scuff- and chip-proof, resistant to sun, frost and the steam of the delousing process.

After this came a multitude of engineering details: cutting the duck, assembling, preforming, curing, trimming, finishing, etc. But the molders managed to take these in their stride and get into production.

Months of molding research and experiment went into this helmet liner, too. The experience of molding thermoplastic football helmets and fabric-base miners' hats helped set the new production procedure on the helmet liner.

Originally, the contractors made single molds with which to experiment, using various constructions and materials.

After making liners of numerous materials and combinations of materials, a resilient, phenolic type laminated canvas construction was found most suitable.

During a period of constant development and tests, steel

*See MODERN PLASTICS, *19*, 35 (May 1942) for an account of the liner molded by low-pressure methods.

1—The Army's helmet liner, molded by high pressure of phenolic resin-impregnated cotton duck, is worn separately as protective headgear. In combat areas, it supports the close-fitting steel crash helmet. 2—Segments of material impregnated with the resin are stapled together in the first preforming operation. 3—Three of these patterns, plus 2 top reinforcements, are assembled into a charge for molding and placed on a conveyor to be taken to the press room

for molds, mold design, etc., were investigated, and tests for sterilization, flexibility and ballistics continued. Climax of this development period was the completion of 200 sample liners of several different constructions, types of finishes, etc., for testing by the Office of The Quartermaster General.

Requirements for M-1 were tough—so tough that although specifications were written last January, it wasn't until many months had passed that actual production began rolling; and it is only now that molding and finishing operations are in full swing in the "Z" plants selected as contractors on this huge project. Some requirements are:

"It shall be made of laminated phenolic resin-impregnated fabric, of substantial uniform density, coated on its exterior with a suitable finish."

"It shall conform to the following detailed requirements when tested within a temperature range of $-40°$ to $160°$ F. and relative humidity range of 10 to 95 percent."

"The weight of the body, without suspension, rivets, chin strap, but with outside coating, shall not exceed $7^3/_4$ oz."

The new liner must also resist a 20-lb. blow, as well as moisture and flame. It is meant to be a sun helmet in the tropics and must not delaminate under extreme heat conditions or moisture. It is worn in cold regions with a wool cap with earflaps or a wool toque in extreme climates. Besides, it must be accurately molded to fit under all conditions within the $2^1/_4$-lb. steel helmet body.

The helmet liner is composed of laminated phenolic resin-impregnated cotton duck and is olive drab in color. The outer surface has a textured, dull, non-light-reflecting finish, suitably resistant to friction and scuff.

In the production process (see Figs. 1–12) the duck is impregnated with the selected resin and cut into wedge-shaped or leaf-shaped sections. A few formulae have been hit on as most suitable for this particular job. The sections of duck are then stapled in a preforming operation. This is a semi-automatic job. In most processes, the rough preforms are placed in basket conveyors which take them to the molding presses. Here, operators remove the preforms and place them in the molds where the liners are cured, and finally re-

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4—A conveyor system keeps the helmet liners moving from one production operation to the next. Here the assembled preformed helmet travels to the molding press. 5—In the hydraulic press, the upper part of the mold will come down with a force of nearly 150 tons, and in a few minutes the preform will be a hard hat. 6—A punch press removes all excess flash from the helmet liner in one operation. 7—Edge of liner is smoothed in burnishing operation

PHOTOS, COURTESY INLAND MFG. CO. AND WESTINGHOUSE ELECTRIC & MFG. CO.

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moved in a partially finished state. The next operation is removing the excess flash in the punch press. This is done in one operation. A burnishing operation smooths rough edges, and eleven holes are punched in each liner by a piercing press. The interior suspension harness, which allows the helmet liner to be adjusted to various size heads, is then riveted in these holes, and an eyelet is set into the front of the liner to hold the soldier's insignia.

At this stage in the game, the helmet liner is in a smooth, shiny state completely unsuitable for modern warfare where concealment is the watchword and any light reflection may be fatal. The next operation consists of spraying a dull resin-textured coating over the helmet liner. In some of the contractors' plants, helmets are then conveyed through a horizontal drying oven for approximately 15 minutes.

Some manufacturers of the liner use a different baking procedure. In one plant, the liners, after spraying, are taken by continuous conveyor through a tunnel in which infrared lamps are installed in close banks. The infrared dryer is 19 ft. long and dries the liners in 95 seconds flat. This development reduces the drying installation cost from $2500 to $600. In the drying system, the hats are placed 15 in. apart and are dried at the rate of 500 per hour. Temperature is controlled at 240° F., the hats being rotated slowly on their spindles as they move along under 4 rows of 250-watt R-40 infrared lamps with built-in reflectors. After liners leave the dryers, they are inspected both by plant and Government inspectors before finally being packed for shipment.

This phenolic-laminated liner has come through such trying tests as the firing of a shot from a .45 caliber pistol directly at the steel helmet under which it is worn, with only slight damaging effects. Its suspension has been so designed that when a man wearing it is struck on the head, it distributes the force of the blow evenly and thus lessens its severity. The liner's behavior in the field, as foretold by its reaction under test, should be a credit to plastics engineering science and to the essential qualities of the phenolic resins which provide its durability and strength.

Credits—Materials: Bakelite, Micarta, Catalin, Durez.

***8**—Liner is positioned in a piercing press, which simultaneously punches 11 holes in it. **9**—Ten are for the rivets which attach the head, neck and chin straps, here being fastened in place by a riveting machine. Eleventh hole is for eyelet which holds soldier's insignia. **10**—A dull coating is hand-sprayed over shiny liner. In some plants, this is done automatically. **11**—Liners dry in 95 sec. under infrared lamps. **12**—Finished liners get a thorough going over*

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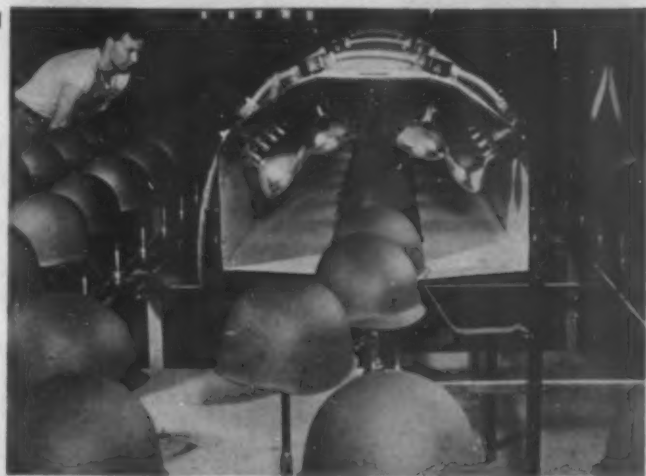

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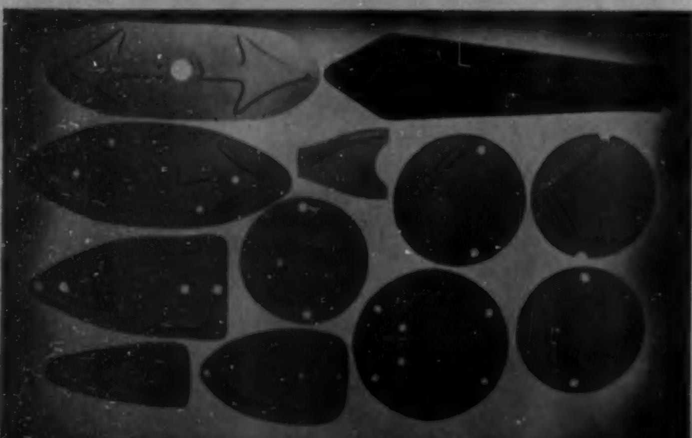

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1 That great bus lumbering down the street probably depends upon dozens of plastic parts to keep it in running order. Some of the smaller units which comprise the Keystone-Faraday low voltage signal system and which contribute to the operating efficiency of the Electric Service Supplies Co. buses are shown here. Push signal switches, directional signals and lightning arresters are all molded of hard, high-impact Durez

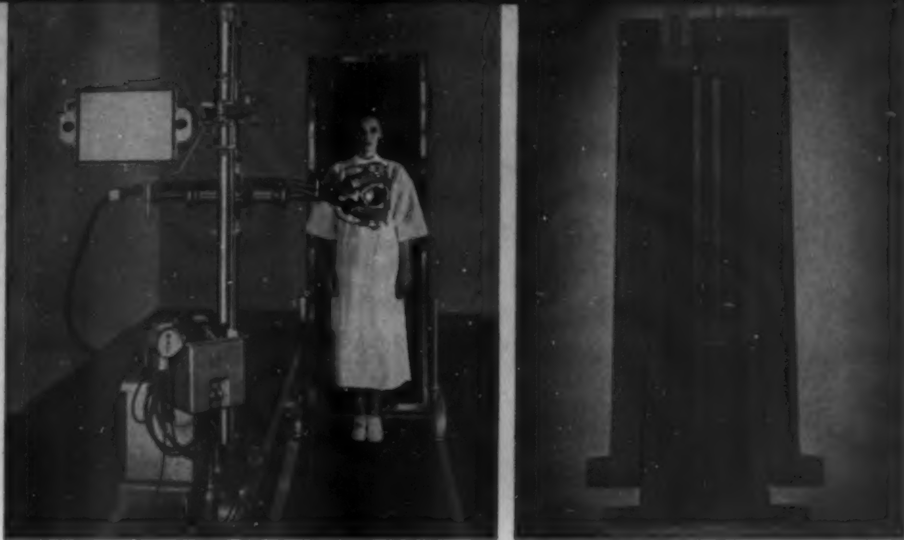
2 Balanced bullets from the land Down Under are made with Tenite II core-tips, shown below in cross section. The exceptional uniformity and dimensional stability of this plastic material result in the production of bullets of even weight and size. Mass production (45 bullet tips are molded at one time) is possible because of the speed with which cellulose acetate butyrate can be molded, and its toughness and light weight add to its efficiency in action

3 These new wide-vision industrial safety goggles from the Chicago Eye Shield Co. are described as offering a 150° effective range of vision. The goggle cups, molded of Bakelite by the Barber-Coleman Co., are contoured to fit the eye sockets. The lenses are held securely in place by means of a molded bar which also permits their removal when replacements are necessary

4 A variety of shapes and sizes characterize these Saran containers whose chemical resistance and limited moisture transmission properties make them highly suited to their function. Molded by Amos Molded Plastics for the Army Medical Corps, these items are also available for private industry either in the black Saran or in acetate, provided priority regulations can be met by the company placing the order

5 Lumarith direction signals point the way to simplified transportation for the Army. Pressed of amber colored, dull finish cellulose acetate, these arrows are manufactured by the Cellulose Co. and used on Army trucks as lenses for cut out metal bases on tail lamps or lamps at the driver's left. The large arrow in the upper right hand corner, which resembles a railroad block signal, drops to indicate a left turn. This tough, transparent plastic has excellent weathering properties

6 The increasing use of high dielectric, high insulation phenolics in electro-scientific equipment is demonstrated by these high tension plugs and sockets (right) which form an indispensable part of H. F. Fischer & Co's Model RF-100 x-ray apparatus. Molded from a mica-filled Bakelite phenolic molding composition by Chicago Molded Products Corp., these units are used at each end of the high tension cables which carry a 10,000-volt current from transformer to tubehead. Since the sockets are in a continuous oil bath, the oil-resistant qualities of this material are of paramount importance. Shockproof, stable and tough, phenolic molding compositions serve every branch of industry where electricity is used



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Plastics in Review

7 Jammed ice trays, frost-burnt fingers and wasted ice cubes may soon be a thing of the past. Here is a new one-piece ice-cube tray, injection molded of Ethocel by the Elmer E. Mills Corp. for Commercial Plastics Co., which has been designed to eliminate the evils attendant upon the old-fashioned ice-cube trays. The low temperature flexibility, freedom from foreign odors and toughness of the plastic material used contribute to the efficient functioning of the unit. Cubes are ejected by twisting the tray from side to side

8 Streamlined functionalism, even to the built-in advertising message, is the boast of this Flash-Ad Electro Pointer pencil sharpener manufactured by Triple "E" Products Co. Molded of either phenolic or urea molding compositions by Kurz-Kasch, this pencil sharpener represents a triumph of handsome modernity. The ad in the housing (above) is invisible except when a pencil is inserted for sharpening, at which time the current flashes the ad on and illuminates the copy. Ingenuity and good merchandising sense have combined to produce this handsome, useful piece of office equipment

9 This watertight socket for marine work, of cold molded composition, meets Maritime Commission specifications, according to the manufacturer. Molded by Plastic Molding Corp. for C. D. Wood Electric Co., Inc., the unit measures 2¾ in. outside diameter and 1½ in. total depth. There are 4 holes around the top circumference through which the holding screws are placed. The socket takes a standard medium size lamp

10 Plastics deliver the goods, and these Tenite containers are helping to deliver them safely, free from the hazards of shipment. Sensitive indicator units for airplanes are sealed into these transparent containers where they are safe from the damaging effects of dust, corrosion, moisture and other elements that might impair their usefulness in service. Instant identification of contents is possible because of the transparency of the material. Manufactured for Pioneer Instrument Co., Div. of Bendix Aviation Corp., these units are now in use for interplant shipments of valuable component parts of aircraft instruments

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PHOTO, COURTESY CELANESE CELLULOID CORP.

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1—The first all-plastic collapsible tubes are molded of pigmented cellulose acetate by continuous extrusion, lined with wax to prevent moisture loss and printed with inks which won't smear or rub off

Extruded collapsible tube

THE first all-plastic collapsible tube, made of continuously extruded cellulose acetate with a special wax lining, is now being tried for products of three well-known manufacturers: Colgate-Palmolive-Peet Co., Chesebrough Mfg. Co., Consolidated, and Ortho Products, Inc. Chesebrough is using the tube for vaseline, Colgate is using it for toothpaste in test areas, and Ortho is studying the use of the new plastic tube for its products. Credit for the new application must be shared by the molding company, who produced the tube; the three users mentioned; and the two manufacturers of cellulose acetate who supplied the materials.

More than a year and a half of work and research have gone into the development of the plastic tube. Colgate originally experimented with a tube made of cellulose nitrate dropped over a form for shaping. These could have been produced at the rate of 80,000 per month, but this was not enough to meet requirements. After it was decided to mold the tube of acetate by continuous extrusion, one of the principal stumbling blocks which had to be hurdled, according to the president of the molding company's statement, was keeping a uniform wall thickness and holding the wall to the proper round shape (.008 in. to .010 in. with a plus or minus tolerance of .00075 in.). This was accomplished, he said, through special extrusion equipment, and he claims that this is the only seamless extruding ever held to that thickness.

This extruded cylindrical tube fits over a molded acetate shoulder or top with a threaded outlet for the cap. The shoulder is affixed to the cylinder through the use of an adhesive and the application of heat and pressure, which provides a perfect seal. The company does not make the caps, which are purchased from makers of plastic closures.

The bottoms of the tubes now on the market are sealed with a metal clip, the Government having allowed metal to be used in the experimental work until machinery can be designed to seal tubes without them. It is possible that this metal may be eliminated with the perfection of an improved method of mechanical folding, crimping and sealing with heat and pressure, which is now in the experimental stage. The manufacturing companies and the Conservation Division, WPB, are cooperating with the molder on this problem.

A machinery firm is working on the development of a machine which will perform this sealing operation. It is planned that the sealing will be accomplished by modification of, and slight additions to, tubing and filling machines used for metal tubes. The clipless crimped and folded closure is not actually heat-sealed but rather a molded fold. A dot on the back of the Ortho tubes assures accuracy of crimping so that the trade design is centered on the front of the tube.

Much work was done by Ortho and Colgate in developing suitable liners for the acetate. Since the products which these companies are packaging in the tube have some water in their bases, the problem of moisture loss is very serious.

Ortho, in conducting its experiments along this line, started out first to find waxes that would withstand varying temperature. The liner had to be plastic, pliable and non-crystallizing at low temperatures, yet non-melting at high temperatures. Bonding to the plastic tube was also difficult. A wax had to be found which would not bind, would not peel

off readily and would not stick to itself. Temperatures used for testing these factors in the wax were 24°, 70°, 100° and 120° F. The company did not find any standard known or available wax satisfactory for the protection it needed, but it developed combinations of waxes, varying to suit the products to be marketed in the tubes, and have shared these developments with other tube users. The ingredients of these formulae are somewhat critical, and whether the wax liners can be obtained for future usage will depend on the future supply of the waxes composing them.

The effect of the liners on the products encased in the tube as well as the effect of products on the liner were given careful study. Slides coated with the different wax formulae were submerged in products to be packaged. After a period of time, these were examined to see what effect the product had on the wax and vice versa. Sometimes the wax was found to be soluble in the product.

Colgate also made tests on moisture loss both with lined and with unlined tubes. The products in unwaxed tubes lost 6 percent of their moisture content when kept at 110° F. for 7 days, which caused the contents to harden and was unsatisfactory. However, tubes which were properly lined lost just about 3 percent moisture in accelerated tests. As a result, the company concluded that contents of the latter would remain for some time in usable and satisfactory condition.

The temperature at which the wax was applied to the inside of the tube was found to be quite important. It was finally decided to use an internal spray of amorphous wax to be applied at 220° F. Also an important factor in so far as distortion of the tube itself was concerned was the length of time taken to apply the wax. The company concluded as a result of these experiments that proper protection was afforded the product if a liner were designed to fit the needs of each particular ointment.

Tubes for products having oily or greasy bases, such as those manufactured by Chesebrough, need no liners because there is no problem of moisture loss.

The inks used for printing designs and trade names on the exteriors of tubes also required special development. Since the products encased in the tubes are used around washstands and other places where water is present, some method had to be devised to keep the inks from smearing and rubbing off. Several months were spent in developing special inks. The combination of these special inks and a thin coat of acetate placed over them after their application to the tube solved this problem. Colgate tested the ink's tendency to smear and found that it would not rub off or smudge when rubbed with the ball of the thumb.

The appearance of the acetate tube at first caused considerable difficulty. A transparent acetate was used and found unsatisfactory from the point of view of eye appeal. Then clear acetate was enameled, and other lacquers and coatings were tried and discarded. Finally the idea of pigmenting the molding compound was hit upon and this method was found to provide an opaque background for color printing that was most satisfactory.

These plastic tubes cost more than metal at this stage of the development, but the increased price is somewhat offset by lighter weight which may allow a lower shipping rate. Cost of the tubes may also be lowered when the manufacturer gets into full production.

So far, the company has all the orders it can handle and states that its present capacity is about 100,000,000 tubes a year. It is estimated by one of the material manufacturers that this will save 2,200,000 pounds of metal.

The Government has issued a warning (Conservation Order M-115) that plastic and other types of tube are not acceptable in exchange for new metal ones.

Credits—Materials: Lumarith, Tenite. Molder, Celluplastic Corp.

2—*Like tubes of metal, the plastic tube may be squeezed up to the shoulder to get out the last smidge of its contents.* **3**—*Plastic cylinder slit to show how it is cemented to molded shoulder (left and insert).* **4**—*A method of folding, crimping and heat-sealing lower end of tube, which is now in the experimental stage*

2

3

4

1

1—*Moldings of the thermosetting composition which are saving critical materials in thousands of pounds: A and D, drinking cup holder and miner's lamp, formerly molded of phenolic. C and E, flush valve and overflow tube, once brass. B, suction blade fan, a former aluminum application. F, battery cover once manufactured of hard rubber*

Molding with non-critical materials

by C. P. MORGAN*

REDWOOD and lignocellulose fibers and resins go to make up a new thermosetting molding composition which contains no critical materials and is designed to take the place of hard rubber and regular thermosetting plastics compounds. This material is said not only to possess properties equal to those of medium quality hard rubber and superior to those of mechanical grades, but also to be adaptable to the equipment of the standard hard rubber manufacturing plant, and to compression equipment of the plastics molders.

Two motives prompted the Vulcanized Rubber Co. to undertake the experimental work which produced this molding composition:

1) To develop from ingredients not needed for war matériel a suitable substitute for hard rubber, and

2) To avoid scrapping or expensive conversion of the standard equipment of existing hard rubber plants.

What laboratory men wanted was a composition that, after mixing in standard equipment, would have sufficient flow when placed in flash or simple plunger type molds to fill them completely before hardening or setting up.

What they finally took from their test tubes and retorts was a compound that combined the properties of both dry and liquid molding compositions yet was unlike either. Under heat and relatively low pressure, it softened and flowed freely through the mold; when taken hot from the press in its molded form, it was comparatively rigid. In appearance, it resembled vulcanized rubber. They named it Colemorite 2-L.

The physical properties of the compound, which were determined by A.S.T.M. standards or the tentative standards set up for hard rubber, are listed in the table at the right. Its general molding characteristics are similar to those of hard rubber in that it requires approximately the same tempera-

* Chief Chemist, Vulcanized Rubber Co.

PHYSICAL AND CHEMICAL PROPERTIES

	2-L	*3-B*
Molding qualities	Excellent	Excellent
Compression molding temperature, ° F.	220–330	300–350
Compression molding pressure, lb. per sq. in.	300–1000	2500–4000
Mold shrinkage, inches per inch	0.0133	0.007–0.010
Specific gravity	1.35	1.40
Specific volume, cu. in. per lb.	20.5	19.1
Tensile strength, p.s.i.	5220	4500
% Elongation	1.61	1.40
Impact strength, ft.-lb. energy, Izod	0.15	0.14–0.16
Rockwell hardness, 60 kg., 1/4-in. ball point	M85–M95	M95–M100
Tendency to cold flow	Nil	Nil
Water absorption, immersion, 24 hr.	0.0–0.5	
Burning rate	Nil	Nil
Effect of age	None	None
Effect of weak acids	None—slight depending on acid	None—slight
Effect of strong acids	Attacked	Attacked
Effect of weak alkalies	None—slight depending on alkali	Slight
Effect of strong alkalies	Attacked badly	Attacked badly
Effect of organic solvents	None*	
Effect on metal inserts	Inert	Inert
Machining qualities	Good	Good
Clarity	Opaque	Opaque
Color possibilities	Limited	Limited

* Ketones are absorbed rather rapidly but without apparent surface defects.

tures, pressures and length of time to cure. Because of its similar exothermic reaction, the same precautions must be taken in its molding, i.e., regulation of time and temperature in accordance with the thickness of the section to be molded.

Equal to if not better than those of hard rubber are its finishing qualities. It is readily machinable, takes an excellent polish and has a good jet black color.

Processing equipment now installed in hard rubber plants can handle this thermosetting composition, and it can be molded with the same type of die or mold. Only in cases where the design is intricate or where cores or inserts are required will some slight changes be necessary.

Success in compounding this rubber replacement led the company to use the basic formula for further experiments. This time a thermosetting molding powder suitable for use with semi-positive and positive types of mold was the object of their research. Such a powder, if it, too, could be composed only of materials not needed by the war machine, would be in a position to replace for civilian uses the vanishing phenolics and ureas, as well as to supplement these materials in war applications.

The Colemorite 3 Series was the result. Known as 3-B, 3-C, C-D, etc., this group of molding powders contains large amounts of wood resins combined with relatively small amounts of non-critical liquid resins. Letters which distinguish series members indicate their degree of flow.

These powders are characterized by a comparatively rapid molding cycle of from 1 to 5 minutes, depending upon press and mold equipment, heat transmission, cooling methods used, whether the molds are channeled or not and, naturally, the proportions of the article to be molded. Mold temperatures are held to 310°–340° F., and the pieces may be taken from the mold while they are still hot.

Although articles molded from the powders have good surface qualities, it has not yet been possible to give them the high lustre found on pieces made from today's standard molding compositions. The powders themselves, however, may be handled according to conventional molding practice.

From tests conducted in individual plants where the new powders are being used, it is apparent that they will be acceptable replacements for powders now difficult to obtain. The variations in formulation of the members of the series enable molders to select powders which fit their needs.

The illustrations on these pages suggest the possibilities both of the composition and of the powders as replacements for hard rubber, brass, aluminum and the phenolics and ureas. As metals and thermosetting plastics grow increasingly scarce, there will be additional opportunities for these new non-critical materials to show what they can do.

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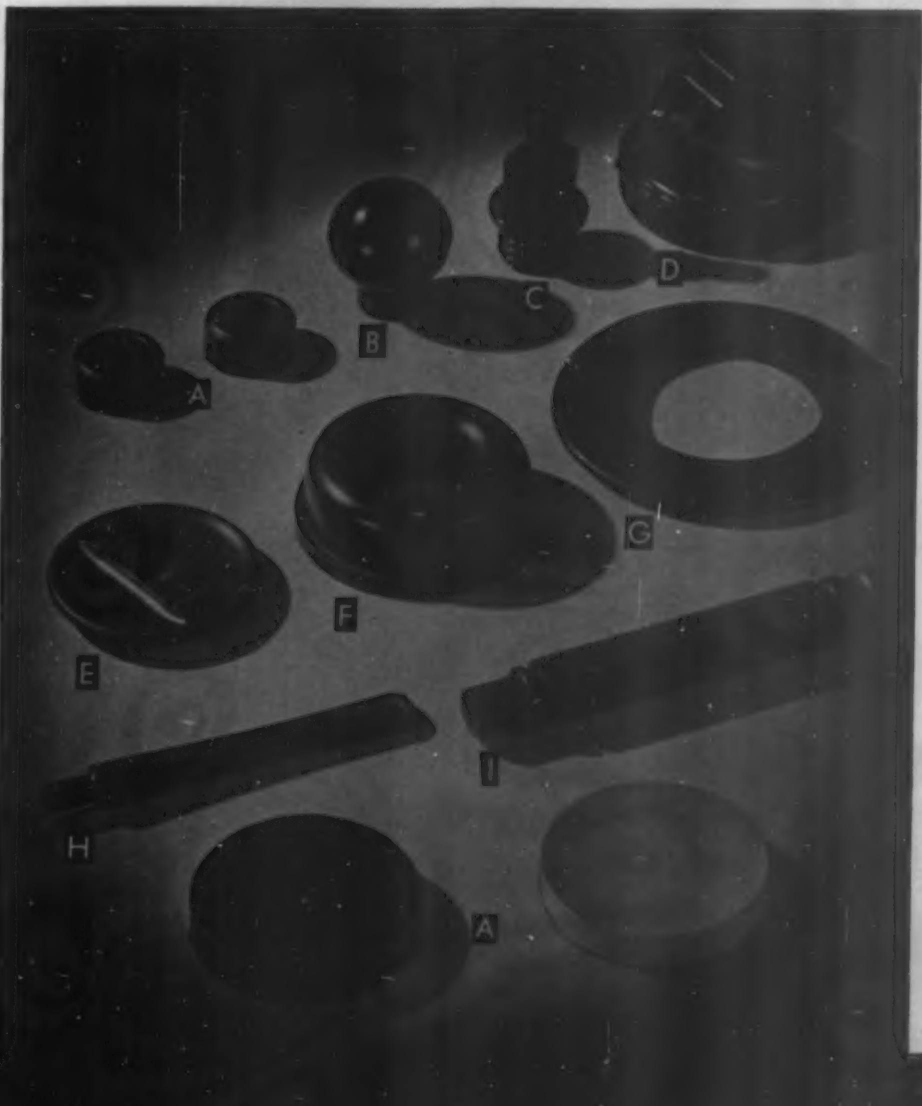


2—Experimental molding of storage battery case once made of rubber. 3—Another group of articles molded of the new compound. A, closures once made of phenolic plastics. The remainder are conversions from rubber: B, knob; C, water bag connector link; D, housing cap; E, truss pad; F, shell sleeve washer; G, battery flange; H, pipe bit; and I, rayon candle filter

Taps for brass

Many an oldster gave a derisive snort when he opened his evening paper a few weeks ago. Beaming at him was a group of happy WAACS, fresh out of Des Moines and lustily singing, according to the caption, "Some day I'm going to marry the bugler."

"Women," growled these whilom doughboys. "What can you expect of an Army full of women? Probably even *like* to get up in the morning. Now in 1917...."

Things have changed a lot since World War I, but not that much. The bugler is still the bugler, and his popularity curve still hovers near the base line at 6 A.M. and climbs abruptly at mealtime. Only his bugle is different. The handsome wind instrument held by the soldier at the left is molded of cellulosic plastic.

Until the plastic bugle[1] was adopted, all standard Army bugles had been made of brass. Although they weighed but 20 ounces, the Quartermaster Corps figures that each of the new instruments will save some 2 pounds of metal because of the waste in cutting the brass. Since it weighs only 10 ounces, the plastic bugle will be easier to handle, lighter to carry about, and less cumbersome for the red-faced young tyro who is learning to blow it.

Its excellent appearance may be judged from the photograph below. Designed in conventional olive drab to harmonize with uniforms and other Army equipment, it may well delight the bugler, among whose daily duties will *not* be the polishing of his bugle! The color is inherent in the plastic, and no painting or rubbing up is needed to preserve its finish.

Improvements made in cellulosic molding compositions and formulations in the last year or two give to this plastic bugle the strength, rigidity and dimensional stability so necessary in any article called upon to double for brass. It can—and probably will—be knocked about a lot without fracturing, chipping or denting, and will be equally indifferent to African heat and Icelandic cold.

Because a bugle is technically a conical-bore tube without lateral openings which relies for its scale on the harmonic series obtained by overblowing, the series produced must depend upon the acoustic principles of the tube itself. The precision with which plastics may be molded makes it possible to design a dimensionally accurate tube with the full compass of eight notes.[2] The new bugle blows more freely than its brass counterpart, say those who have tried it, adding that it shows no tendency to choke up. Brass bugles need to be "warmed up" with a few practice notes before the calls are sounded. Plastic bugles don't. If the first notes are sour, it's the fault of the blower, and can't be blamed on the bugle.

The new plastic bugle was developed by Elmer E. Mills Corp. in conjunction with Chicago Musical Instrument Co. in response to a query from the Quartermaster Corps as to whether such an instrument could be molded practically—or, indeed, could be molded at all. The two companies had previously worked together to produce toy bugles (Bugle Boy, Cadet Bugler[3]) of injection-molded cellulose acetate which had good tonal qualities, and were not dismayed at the thought of designing and fabricating a bugle for grown-ups, or even for the U. S. Army. Particularly since there was in the employ of the latter company a craftsman, Frank Aman, whose talents were eminently suited to the musical phase of the development.

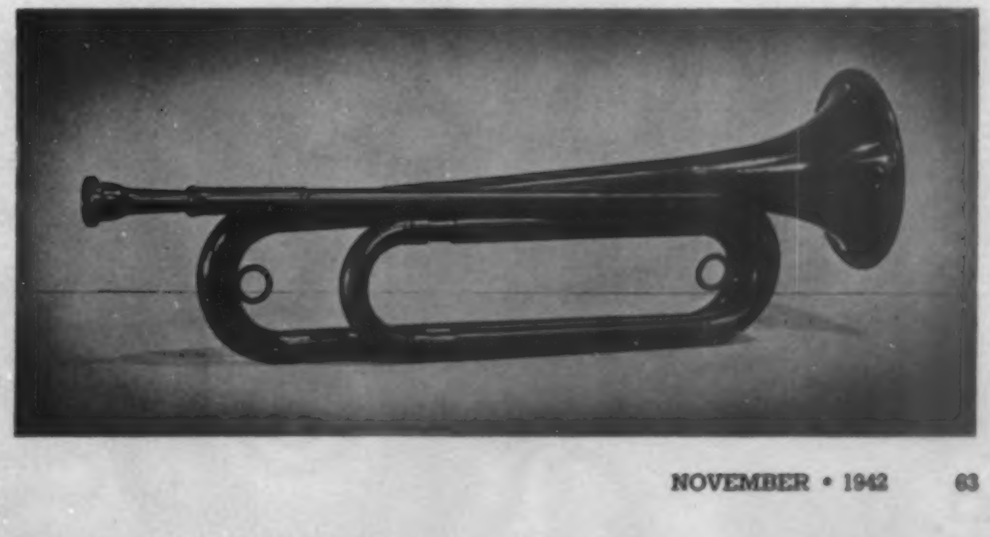
Born in Hungary, of a family of musical instrument makers, Mr. Aman came to the U. S. at the turn of the century. Already to his credit are the first conical-bore flute with Boehm system fingering; a horn bearing his name which he describes as a cross between an English horn and a soprano saxophone; and, after importations of European instruments were cut off, the first American-made bassoon. Plainly Mr. Aman was equal to a plastic bugle, and the model which he designed was made up and taken to Washington to be compared with bugles of brass.

Blower of the plastic bugle in its début before QMC dignitaries was the solo cornetist of the U. S. Army band, reputedly the best bugler in Washington. The verdict was favorable in the extreme: its tone was adjudged superior to that of the Army issue bugle, and equal in quality to that of the more expensive instruments in its field. Part II of the test concerned the bugle's carrying powers, and for it the critics separated themselves by a good half-mile from the bugler, who was supposed to advise them by signals when he was blowing which bugle. As it turned out (*Please turn to page 134*)

[1] Precisionists in musical terminology, for divers and complicated reasons, prefer to call the instrument a trumpet. To those who are daily at its beck and call, however, it's a bugle; and we'll go along with the men in uniform.

[2] Only five notes are actually required for the Army's 41 bugle calls.

[3] See Modern Plastics *18*, 110 (October 1940); 43 (July 1941). Bugle Boy won an Honorable Mention in the 1940 MODERN PLASTICS Competition.



The original plastic bugle which journeyed to Washington, passed all of its tests, and will be molded in quantity for the Quartermaster Corps

Aerial view of sugar factory, showing stacks of bagasse in background. The material is shipped in 120-lb. bales

Bagasse molding compounds

by T. R. McELHINNEY*

BAGASSE is the residue remaining after the extraction of juice from sugar cane. As received for use in making plastics, it is in the form of bales weighing approximately 120 lb. and containing about 10 percent moisture. A previous aging during a six months' storage period has resulted in some fermentation, which effectually destroys the residual sugars remaining after the extraction. The crushing and extraction process, termed "grinding" by sugar mill operators, has reduced the cane to shreds averaging about 3 in. long and $^1/_2$ in. wide in which some separation of pith from the outer cortex fiber has taken place. Chemical analyses, based on the dry weight of the material, show an average of 18 percent lignin, 45 percent cellulose, 15 percent water extractives and the remainder hemi-celluloses.

A number of years ago, the Agricultural By-Products Laboratory at Ames, Iowa, attacked the problem of using bagasse as a source of plastic material. The initial work was done with the objective of applying methods developed at the Forest Products Laboratory at Madison, Wisconsin, for making plastics from wood.[3,4] These methods, applied to bagasse, showed immediate promise.[1,2]

Among others, the firm of Valentine Sugars, Lockport, La., became interested in these processes and obtained licenses to operate under the Public Service Patents[3,4] held by workers at the Forest Products Laboratory. Pilot plant production of these molding compounds was started at their Lockport plant late in 1939. The product offered for commercial use was a considerable improvement over the laboratory product insofar as molding characteristics were concerned, but it did not meet with any commercial success. Chief among its shortcomings were the excessively long curing time required, poor flow qualities and excessive gassing during molding. In view of these difficulties, all attempts at marketing the product were discontinued for over a year and all efforts devoted to elimination of the shortcomings of the material.

As a result of this year of intensive research, a product was finally developed which was comparable in most respects with the general-purpose thermosetting compounds previously on the market, and which had certain advantages over many of them in shortness of curing time, flow and finish. A few tons of this material were manufactured, sold and successfully used for commercial articles. As this is written, shortages of essential chemicals are handicapping the manufacture of these products; but tests and development work are still in progress, and it is hoped that by the time this article appears in print commercial operations will have been resumed, at least on a small scale.

Development

Following the failure of the initial products manufactured under the patents mentioned above, work was directed toward improving the flow of the material and decreasing its curing time to a period which would be commercially satisfactory. This was accomplished to a considerable degree but, since the process was originally based on the production of a resin *in situ* in the bagasse, the eventual result of this work was that the treatment necessary to give the resin the desired characteristics almost entirely destroyed the strength of the fiber filler remaining. At the same time, so much of the degraded fiber was still present, admixed with the resin, the compound would not tolerate the addition of more filler to strengthen it without too much loss of flow. Because of these results, the process was divided into two parts: the development of a resin from bagasse with complete destruction of the fibrous and non-reactive portions; and a parallel development of a satisfactory filler from bagasse. Results were gratifying and an excellent resin was developed. After considerable additional experimentation, a filler was developed from bagasse which, when used in combination with the bagasse resin, was superior to woodflour and other common types of filler. Some inherent property of the bagasse filler allows it to combine with the bagasse resin in such a way that flow and strength qualities are much better than when woodflour is

* Technical director, Valentine Sugars.

TABLE I.—PHYSICAL PROPERTIES AND CHARACTERISTICS OF 4 TYPICAL BAGASSE PLASTIC COMPOUNDS[1]

Compound	*A*	*B*	*C*	*D*
Molding quality	Excellent	Excellent	Good	Good
Molding temperature, ° F.	300–350	300–350	300–375	300–375
Molding pressure, p.s.i.	2000–3000	2000–3000	2000–10,000	2000–10,000
Compression ratio	2.5	2.5	3.0	3.0
Specific gravity	1.35–1.40	1.35–1.40	1.30–1.40	1.30–1.45
Flexural strength, p.s.i.	8900	9500	10,160	9500
Impact strength, unnotched Izod, ft.-lb., 1/2 in. × 1/2 in. bar	1.10	1.00	1.39	1.25
Resistance to heat, ° F.	350	380	400	400
Dielectric strength, volts per mil, step	250	....[2]	....[2]	....[2]
Water absorption 48 hr., percent	0.90	0.75	....[2]	....[2]
Burning rate	Very low	Very low	Very low	Very low
Effect of age	Apparently none			
Effect of weak acids	Slight			
Effect of alkalies	Slight surface roughening, 168 hr. boiling with 25% sodium hydroxide			
Effect of organic solvents	None, to a slight surface roughening			
Effect on metal	Inert	Inert	Inert	Inert
Colors	Dark	Dark	Dark	Dark

[1] Due to the limited amount of commercial experience with these materials, only limited laboratory results are available. Data given above should only be considered as indicative of the properties of these materials and not taken as a guarantee of performance.
[2] No data available.

used. Substitution of phenolic resins for the bagasse resin with this filler gives opposite results, although the reason for this has not at present been determined.

The advantage of developing a resin separate from the fibrous filler is of course obvious. Resin to filler ratios can be varied at will in accordance with the particular characteristics desired in a molding compound. Special purpose compounds with high impact strengths combined with good preforming qualities and easy flow are now available. The separate resin also has the advantage of being available for impregnation work in the manufacture of laminated materials, although at present its use for this purpose has been confined to the lamination of paper. It gives particularly good results in the lamination of a special paper made from bagasse.

General characteristics

Molding powders can be furnished in granulated form in black and standard shades of brown. Preforming properties are generally good, although it has occasionally been found that, in certain types of preforming presses, some minor adjustment must be made from their setting for the usual type of phenolic material. Some of the physical properties of four typical compounds are shown in Table I. All of these compounds mold readily at temperatures of 300 to 350° F. at pressures from 2000 lb. per sq. in. and up. Curing time is about 1 min. in a 1/8 in. wall thickness, varying somewhat with the shape of the piece and the molding temperatures used. Small jigger cups have been successfully made with a 45-sec. cure without preheating. Due to the nature of the material, there is no marked difference in curing time between the softest and hardest grades of powder, although it has been found that the hardest grade practical for any given molding will give the best finish in the molded piece.

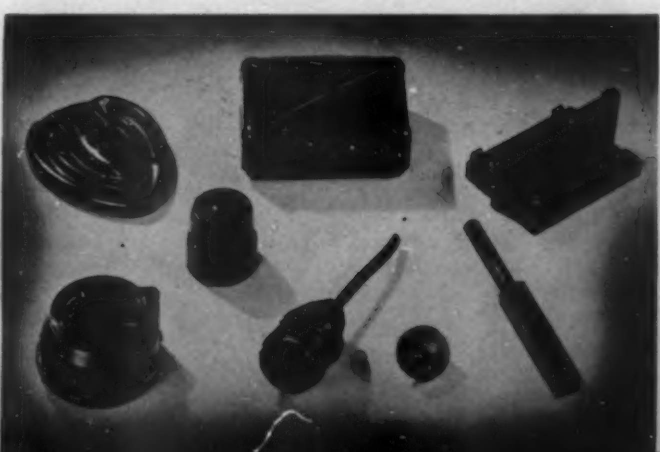
An unusual property of these compounds, advantageous for some applications and detrimental in others, is the unusual softness and flexibility of the material when first ejected from the mold, even after protracted curing periods. This softness does not occur again on reheating, even to temperatures as high as 400° F., nor has it ever been found to affect the accuracy of finished pieces by causing warping. This property is distinctly advantageous in molding screw cap closures as the material is easily stripped from the mold without distortion.

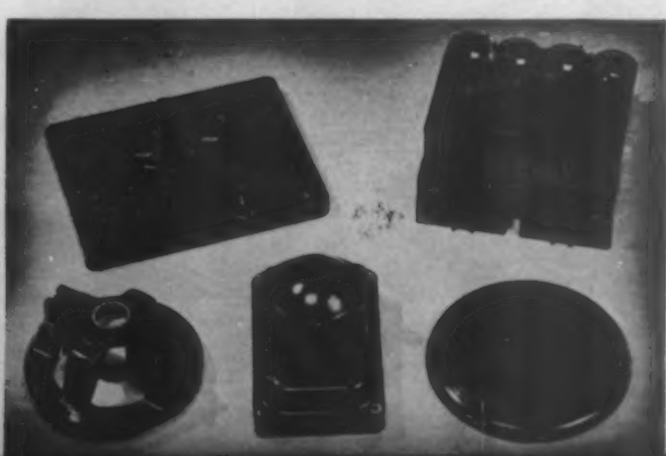
Laminating resin is available in the form of a 40 percent alcoholic solution. Laminating sheets and laminated boards are at present available only in experimental quantities. Boards can be molded in a 1/16 in. thickness in 2 to 3 min. at temperatures of 280° to 300° F., and pressures of 1500 lb. per sq. inch.

Recent developments

Restriction of essential chemicals used in the manufacture of the first line molding compounds prompted research on a substitute product made without any priority material. Such a compound is now available, consisting of approximately 70 percent processed bagasse and a (*Please turn to page 136*)

Two groups of commercial and experimental pieces molded from bagasse plastics in ordinary flash type molds





Lightweight replacement

Priority-beset industry is turning increasingly to plastic materials to relieve the strain on metals. This safety belt guard (below) of cast phenolic is the first of a number of "war production" changes being made on a duplicating machine (above) turned out by one manufacturer.

In substituting cast phenolic for cast aluminum, it was necessary to redesign the housing slightly and increase the wall thickness to strengthen the construction. Despite this change, the cast phenolic housing weighs approximately 25 percent less than the original aluminum casting. The ease, economy and speed with which cast phenolics may be put into production, and the fact that the casting process eliminates the need for expensive molds or complex molding equipment, make this a change that is right in line with the need for speed in all industry today. The resistance to moisture and lubricants, excellent chemical resistance, hardness and beauty of the material combine to make this conversion an advantageous one so far as both appearance and operating efficiency of the machine are concerned.

According to a statement from the manufacturer, so satisfactory has the conversion proved that the changes incorporated in these war emergency models will be featured in their postwar selling program when material shortages will undoubtedly give way to material plenty.

Credits—Material: Catalin. Fabricated by Plastic Turning Co. for Standard Mailing Machine Co.

PRODUCT DEVELOPMENT

Tough bayonet scabbard

One hand grasping the handle of his bayonet, the other on his scabbard, this U. S. soldier is prepared for any emergency and equipped to meet all comers. Formerly made of wood, leather and canvas, this new scabbard is now molded with speed and efficiency of duck impregnated with cellulose acetate butyrate. The resultant piece of equipment is not only less expensive and easier to produce than the original model, but is lighter in weight and capable of withstanding severe impact at extremely low temperatures without breaking. Easier to keep clean than the old style scabbard, the plastic sheath is also less likely to swell and shrink. It is described as the most efficient yet developed by the Army for hard service.

The finished scabbard is free of burrs and rough edges, and is capable of supporting a 15-lb. weight for one minute without permanent deformation. To conform with rigid Army Ordnance Specifications, acceptable plastic materials must be capable of withstanding such extremes of temperature as −40° F. and 170° F. with no ill effects. To assure proper functioning at all temperatures, these scabbards are tested at 170° F. with a one-pound load, and acceptable scabbards must show no permanent deformation. At −40° F., specimens are tested by a sharp blow equivalent to the impact of a 4-lb. weight dropped a distance of 2 ft., 9 inches. All scabbards must meet these tests without breakage or failure at any point.

Credits—Material: Tenite II. Molded by Victory Plastics Co.

Transparent feeder units

The same plastic material that not so long ago was used in the creation of sparkling costume jewelry and eye-catching baubles is now doing a major job in industry. One of the more interesting current industrial applications of methyl methacrylate resin is its use in transparent moldings on chemical feeder assemblies used in purification processes.

To increase the efficiency and utility of their equipment, some manufacturers are making the internal workings of their feeders visible from the outside by incorporating entire valve blocks, pump valves, reagent heads and inspection windows of methyl methacrylate in this type of equipment. The clarity of the material helps the operator to follow the feeding process and makes possible detection of any foreign matter which may disrupt the function of the chemical feeder.

Calcium and sodium hypochlorite solution, sodium ash, alum, which are frequently used in these emulsion feeders, are among the chemicals to which these plastic units have demonstrated their full resistance with no loss of transparency. Nor does hydrofluoric acid, used in metal pickling processes, affect the material.

Hardness, shock and impact resistance, and the fact that these units can be turned out quickly and efficiently in great quantities, enhance their value as prime replacements for rubber and metal parts formerly used.

Credits—Material: Lucite, Crystalite. Molded by Molding Corp. of America for Percent Proportioneers, Inc.

PRODUCT DEVELOPMENT

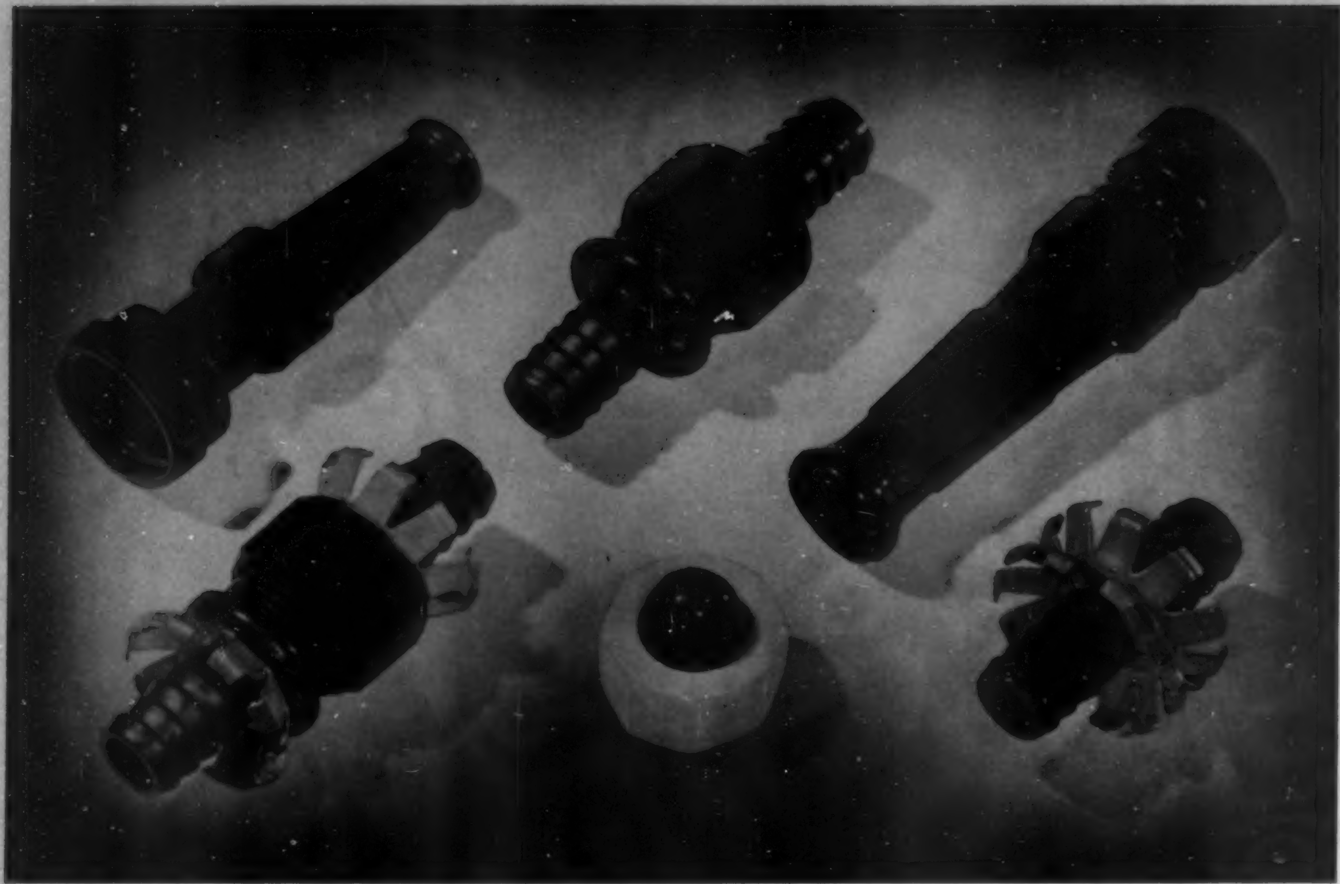
Double-duty housing

"Two-in-one" might be the designation for this molded phenolic housing. The housing has been designed to fit not one machine but two—a printing calculator and an adding machine—making it possible for one mold to do the job of two. The keyboard guide plates and ribbon covers differ slightly in the two machines, but their overall dimensions are identical so that both sets will fit into the new housing. The housing can be precision molded in one operation, thus lending itself to economical mass production. Its light weight makes it peculiarly suitable for a portable machine.

Because smooth, shining surfaces catch highlights which, aside from engendering eyestrain, might distract the attention and interfere with the efficiency of the operator, it was decided to incorporate a dull, non-glare, wrinkle finish in the new housing design. The wrinkle finish is baked in after the housing comes from the mold, and the key plates and ribbon covers form a smart contrast with their high finished surfaces. Outstanding among the advantages claimed for the new phenolic housing is that it has noiseproofed the machine by eliminating the clatter of the reverberating metal unit.

Upper photograph shows the housing, with keyboard guide plates and ribbon covers as they come from the mold. Note the smooth finish as compared with the glare-free wrinkle finish of the completed unit shown below.

Credits—Material: Durez. Molded by Reynolds Molded Plastics Div., Reynolds Spring Co., for Remington Rand, Inc.



Injection molded in gay colors of special thermoplastic formulations, these garden hose accessories are lightweight, moisture-resistant, non-corrosive and impervious to temperature changes

Thermoplastics in the garden

IT may seem like a far cry from flourishing victory gardens and grass-carpeted front lawns to the plastics industry, but there is a decided connection between the two.

As far back as June 1941, one manufacturer of brass garden hose essentials, anticipating future shortages, began his task of conversion. Since even at that time thermosetting plastic materials were being diverted to wartime uses, the thermoplastic group was the one that remained for the purpose under consideration.

A search was immediately instituted for a single material that would combine in one formulation all of the properties needed for hose couplings, nozzles, sprinklers, menders and other garden hose accessories. For such applications there were definite essential requisites such as colorfastness, resistance to moisture, temperature changes and shock. The material had to be tough, lightweight, stable, warp- and corrosion-proof, pleasant to the touch and available in a wide variety of attractive colors.

Experimental work was carried on with practially all of the available thermoplastic materials until it was found that special formulations of ethyl cellulose, polystyrene, cellulose acetate butyrate and, for one specific application, vinyl acetate, were the materials best suited to the exigencies of the particular problem at hand. These materials, according to the manufacturer, are being used because they seem to conform most satisfactorily to the exacting physical and mechanical problems involved in the manufacture of these items.

The construction of injection molds for these units proved another delicate problem. All molds used are of the multiple cavity type, averaging ten cavities to a mold, although some molds have twelve and others six or eight cavities. Because all hose parts must be precision fitted, they require extreme accuracy in the construction of the die and the mold. Most of the units have internal or external threads which are molded to size, integrally with the main mold job. All nut dies used are of the automatic type, the internal thread cores being automatically unscrewed during the ejection operation of the cycle. The unscrewing mechanism is incorporated in the die, and actuated from the outside by a special motor.

The experimental or test period for these items has long passed. Some of them have been on the market for well over two years, and their continued use and growing acceptance bears eloquent testimony to their satisfactory service. In the words of the manufacturer, the service obtained from these items is in direct relation to the treatment they receive in usage.

Credits—Hose fittings molded by Amos Molded Plastics Co. for H. B. Sherman Manufacturing Co.

Unusual costs in war work

As many in the plastics industry have found, the Government is a tough customer. There are certain cost factors present in Government business which either do not arise at all or come up in less degree in private business. In bidding on Government contracts, or in sitting around the conference table negotiating prices with Government men, there are cost factors which, if ignored, are likely to be fatal.

For some time, MODERN PLASTICS has watched this situation develop. More than a few cases have come to the attention of the editors where ignorance of these factors or failure to do something about them has cost, in the aggregate, a good many thousands of dollars to molders, fabricators and laminators. Recently, this magazine sent a questionnaire to leading molders, laminators, fabricators and material manufacturers, asking them what unusual cost factors they had experienced in Government business. Specifically, they were asked to discuss the effect of *changes in design* while the job was in process, *rigid specifications, short runs, development work* and *"tough" inspection.* In addition, they were asked to state any other cost-increasing factors which had affected them in working on Government business.

Design changes

Discussing changes in design, one molder said, "We believe that every manufacturer has had interference in the way of changes, not particularly in respect to designs as far as we are concerned, but in respect to minor details. On one contract we have been held up for some time because of some little detail which has nothing to do with the original specifications, but which was an afterthought."

Says another, "We happen to have a customer for whom we have made at least ten different molds. Out of the ten molds there was never one that didn't have to be changed afterwards, and three or four of them became obsolete when we finished making samples. We have not as yet finished one complete order on these ten molds. There's always some change, some alteration which interrupts production."

Inspection and specifications

Production expenses incurred as a result of last-minute changes in design were not, however, the main difficulty, for the biggest single headache in the plastics industry's dealings in Government business has apparently been on inspection and specifications. With but few exceptions, every person answering the questionnaire had something to say about the problem of rigid specifications and "tough" inspection.

"With the ordinary commercial customer," one contractor stated, "specifications can be clarified by a meeting of engineers. This is done without unreasonable loss of time and gives the production department a clear track so that they can meet their schedules. With specifications on war work, any quick change is almost impossible and the uncertainty of extra operations with their resulting inspections must be weighed carefully in summing up the cost items. In the past we have gotten into the habit of ironing out our troubles with our customers as we went along. With war work we cannot hope to do this and our original estimates must recognize this fact in connection with any uncertain point of quality or inspection."

"Under the subject of rigid inspection," another molder revealed, "is where we have experienced the greatest increase in cost. This increase occurs in two places. First, because of the closer limits on Government work, our percentage of rejects is considerably higher. In civilian work it is quite often possible to get a deviation on a certain quantity of parts that are in excess of the allowable limits, providing the correction is made on future production. This, of course, is hardly possible on Government work, as an inspector cannot be familiar with how every piece is used and therefore cannot take any chance."

Government suffers

One manufacturer, in discussing his problem, stated flatly that the principal sufferer is the Government," . . . as purchases could be made at a lower cost if such uncertainties were not injected into the picture.

"I am prepared," this manufacturer wrote, "to state that a manufacturer could not tolerate such liberties from civilian consumers . . . and must of course see to it that he is amply protected on the prices which he bids."

A rather bitter complaint came from a fabricator who claimed that sometimes the dimensions in question had nothing to do with the function of the piece itself. He also stated that Government inspectors have a complete lack of knowledge of manufacturing processes which makes it impossible to do business with them.

On the other hand, many praised the Government inspectors and other Government production officers. "We are greatly impressed with the high type of individuals," said one very large manufacturer, "that we come in contact with on the technical procurement and planning end of Chemical Warfare Service. We find that these fellows 'know their onions' and that they readily appreciate any suggestions that we might offer which would tend to more efficient molding practice . . . . The Government agencies have been extremely

COSTS TO WATCH ON GOVERNMENT WORK

1. Government work will increase overhead expense, due to need for more clerical help to handle countless Government papers.

2. Each contract obtained must be regarded as a unit. Don't depend on repeat business to pay off the cost of mold making, because specifications may change.

3. Inspection is tough—figure on rejects in calculating price.

4. Combination of skilled labor shortage and constant demand for more production may mean much overtime work at time and a half pay. Check your situation to see if you will have this problem.

5. Traveling expenses for key men can reach unexpectedly large sums. Try to anticipate them in figuring profits.

6. Developing new methods and products will be costly because change comes so rapidly in wartime design.

fair in all details, especially in helping out on getting materials, tools and other necessities to keep our production line going."

Another large midwestern molder complimented the Government inspectors by saying, "We have been very pleased with the cooperation we have had from the inspectors of both the Army and Navy divisions. They have been willing to cooperate in every way consistent with good manufacturing."

Material specifications

A fairly typical complaint came from one molder regarding material specifications. He said, "Our present period of material shortages makes the rigidity of material specifications all the harder in that similar material cannot be substituted when that required is not available. Jobs are held up until the specified material can be obtained and often a job which has been substituted must be stopped in order to permit the continuance of the first job. Thus breakdown and setting up costs are unnecessarily incurred. In connection with rigidity of tolerances, reworking and closer inspection are required on parts where tolerances could very easily be increased without affecting efficient operation of the assembled product. Closer study of the item to be produced, and discretion in the determination of required specifications will not only enable production to be accelerated but will also aid in the reduction of costs."

Uniform inspection needed

A complete lack of uniformity in inspection methods was charged by many of those answering the questionnaire. This was succinctly stated by a laminator who said, "Inspection, in my opinion, is one of the weakest links in production endeavor. One inspector after another will set up different standards and from day to day standard requirements will change. It seems to me that an inspector should be schooled in the thought that his job is to select and secure products that can be used and will meet the required conditions, rather than approach it from the negative side, endeavoring to discover reasons and causes that will enable him to throw out the product."

Another molder put it more briefly: "Some of the specifications we have encountered are absolutely nuts. Attempting to revise them to a saner plane resolves itself into a job similar to filling a four-motored bomber with an eye-dropper."

Incomplete specifications was the subject of one complaint. "Rigid specifications have not bothered us as much as incomplete specifications which result in the inspectors' applying their own standards, which are not always sound or in accordance with our own manufacturing standards. At this time we have approximately $15,000 in rejects tied up in one item by Army inspectors *which are in exact accordance with previous large shipments made and known to have worked satisfactorily.*" (Emphasis supplied.)

Development work costly

The necessity of bearing the costs of development work without reimbursement is also a factor which most of those answering the questionnaire discussed in detail.

"Development work," said a large midwestern molder, "is costly, requiring frequent trips for discussion with the War Department and as a result of mixed opinions, ultimate decisions are too frequently not to the best interests of all parties."

Another company stated that it had increased the staff of its development and research department threefold, spending "many thousands of dollars" in preparing samples and conducting tests.

One unique complaint came from the eastern section of the country. A molder there said, "Lost time on other jobs caused by breaking into production to do the experimental and production work necessary to develop suitable substitute designs and materials in plastics has cost large sums."

A material manufacturer claimed that laboratory development work during the past few months has more than doubled. "This has not necessarily resulted in any radically different compounds but it has resulted in many changes in existing compounds necessitated by the inability to obtain certain types of raw materials formerly utilized . . . for example, certain compounds used as ammunition components have been changed considerably in their chemical makeup to make them non-reactive with various types of explosives."

"Labor costs have been run up due to development work," one eastern molder revealed. "Expert skilled help must be obtained in order to properly carry on necessary development work; and in the present labor market, rates for such skilled men are very high and the men hard to find."

There were many complaints that development work had to be done in order to get Government contracts, and then the contracts did not justify the cost of such work.

Two typical complaints along this line were voiced by a fabricator and a molder. Said the fabricator, "In a number of cases we have spent considerable time on a project only to find that it is solved in some other manner and we don't obtain the job. . . . . The cost of this work must be added to some other job, thereby increasing its cost. On many of the projects on which we are doing development work, we can only hope to market the product during the war period and possibly not even for the duration of the war, because new resins, etc., are coming out, sometimes within a period of 2 or 3 months after our work is completed. In development work on fabrication of the type of work we do, we have found it necessary to use production size machines. This means that we waste considerable material, power, time, etc."

The molder's complaint was more bitter. He said, "We have a contract which amounts to $2000 which, before we get through, will cost us $5000. When we called attention to the cost of such preparation it was intimated that the Department expected cooperation along such lines and the inference was clear that if we did not cooperate a bad impression would be created in Washington."

There is one very good aspect of this situation on development work. It is that many in the plastics industry have had the necessity for standards brought forcibly to their attention. One molder expressed it this way: "Added costs accrue in many instances because the Government Departments concerned are unfamiliar with plastics. The plastics industry has no standards for materials similar to, let us say, those of A.S.T.M. All jobs are rush, requiring considerable long distance telephoning, trips out of the city to discuss recommended changes and revision of specifications, and the usual difficulty of getting blueprint revisions through the multitudinous offices, branches and sub-branches of the governmental agencies concerned."

A large eastern manufacturer suggested a solution to this problem of standards, at least in so far as war work is concerned. He said, "The cost of development work has been greater within the past 6 to 8 months due to the fact that movement of products through normal channels has been cut by the necessity of using the (*Please turn to page 122*)

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John Wesley Hyatt Award presented

THE annual John Wesley Hyatt Award for an outstanding contribution to the plastics industry during the year 1941 was conferred on Dr. Donald S. Frederick, of Rohm and Haas Company, at a dinner given at the Waldorf-Astoria Hotel, New York City, on Friday evening, Oct. 30.

Dr. Frederick was honored for his work in adapting transparent, colorless acrylic plastics to the needs of American military aircraft. Prior to the successful development of sections of this plastic large enough to make the nose of a bombing plane, the use of plastics by the aviation industry had been limited to areas considerably smaller in dimensions. These large-size plastic sections, aviation experts believe, give to our planes an advantage not held by those of other countries.

Plexiglas, the methyl methacrylate plastic used in the development work of Dr. Frederick and associates, forms cockpit enclosures, gun turrets, broad windows, domes and other key parts as well as bomber noses. In connection with Dr. Frederick's work, new methods had to be perfected to make large, transparent sections accurately curved to conform to the contours of a plane. Similarly, new fabricating methods were developed to form large two- and three-dimensional curved dome sections that would meet the high optical standards required.

The award, established by Hercules Powder Company last year, was named for John Wesley Hyatt, who is credited with having been the inventor, in 1867, of the first plastic —a mixture of nitrocellulose and camphor, out of which came the present-day Celluloid. In winning this award, Dr. Frederick received the Hyatt Gold Medal carrying a profile relief of John Wesley Hyatt, designed by the famed artist

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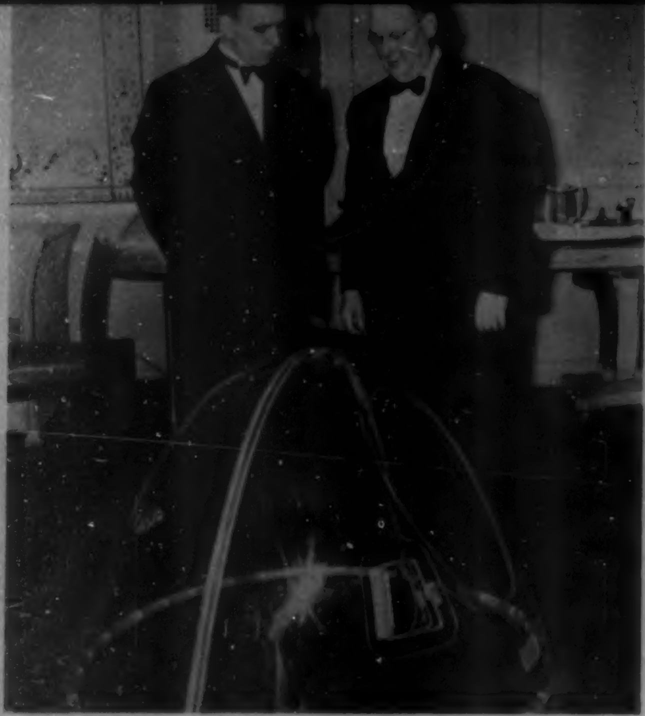
1—Dr. Lyman J. Briggs, Director of the National Bureau of Standards, presents the Award to Dr. Frederick (left). 2—Ralph W. Hyatt, son of John Wesley Hyatt, chats with Dr. Frederick.



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3—Methyl methacrylate bomber nose, one of Dr. Frederick's plastic applications. At right is SPI President Ronald Kinnear. 4—C. A. Higgins, president of Hercules Powder Co., sponsor of the Award, examines the large bomber unit. 5—Paul Manship, designer of the medal (right), discusses it with Ralph Hyatt. 6—Detail of both sides of medal, showing profile of John Wesley Hyatt

and sculptor, Paul Manship, and one thousand dollars.

Dr. Frederick, who was born November 13, 1910, at Hamilton, Ohio, received his bachelor's degree from Miami University in 1931. His graduate work was done at the University of Illinois, where he received his master's degree in 1932, and his Ph.D. in 1934. The subject of his doctor's thesis was "Synthetic Resins Derived from Sulphur Dioxide and Clefins."

From 1934 to 1936, he worked in Rohm and Haas' acrylic research laboratories, and on semi-plant production of Plexiglas. In 1936, he was made sales manager of the plastics division, and since that time he has also headed his company's technical sales force.

Dr. Frederick is a member of the American Chemical Society, the Society of the Plastics Industry, Phi Lambda Upsilon, Phi Beta Kappa, Phi Kappa Phi and Sigma Xi. He has written a number of articles in chemical, plastics, aeronautical, and other trade and technical publications.

Watson Davis, Director of Science Service, Washington, D. C., was toastmaster at the dinner, which was attended by a group of men prominent in the plastics industry. The award was presented to Dr. Frederick by Dr. Lyman J. Briggs, Director of the National Bureau of Standards.

Ralph W. Hyatt, son of the man in whose honor the award has been established, spoke reminiscently of his father's times and work, and SPI President Ronald Kinnear, whose grandfather was associated with the elder Hyatt, added some information relative to the early days of the plastics industry. In accepting the award, Dr. Frederick shared the honors for his development with his associates at Rohm and Haas, and observed that the work of his competitors, E. I. du Pont de Nemours & Co., Inc., with Lucite applications had acted as an additional incentive.

This was the first presentation of the Hyatt Award, which will be made annually by the John Wesley Hyatt Award Committee. The committee is composed of the following: Richard F. Bach, Dean, Education and Extension, Metropolitan Museum of Art; Dr. Lyman J. Briggs, Director, National Bureau of Standards; Dr. Karl Taylor Compton, President, Massachusetts Institute of Technology; Watson Davis, Director, Science Service; Eric Hodgins, General Manager, *Time* magazine; Dr. Harry N. Holmes, President, American Chemical Society; Ronald Kinnear, President, Society of the Plastics Industry.

It was announced that William T. Cruse, Executive Vice President of SPI, would serve as secretary of the Committee for the coming year.

Case history of a register

NO plant producing materials of war can afford to admit strangers without making sure that they are the persons they represent themselves to be. If, after he has shown his credentials, each visitor fills out a brief form in his own handwriting, thereby leaving a fingerprint or two on the sheet, there is an additional check on his identity.

This and many another record-keeping job in the wartime industrial plant is simplified by the use of such modern business machines as the portable register. One such machine has in the past been enclosed in a stamped aluminum housing, which provided the necessary lightness for a unit designed to be carried in the hand (see Fig. 1).

When the aluminum situation became tight, a search was begun for another material to take its place. After a series of experiments, a standard phenolic was decided upon as best suiting the requirements for lightness, dimensional stability, strength and good appearance.

Certain basic requirements for this new plastic design were agreed upon by the molder, the engineering departments and the designers. These were as follows:

1) The case must be comfortable to hold.
2) The operations must be simple yet positive.
3) The assembly of the operating unit into the case must be foolproof.

Every component of this register was carefully studied with reference to its adaptability to plastics and the final design came up with 10 separate plastic parts. The 2-piece case, hinged doors, operating handle and small knob were naturals for plastic adaptation. But it took real designing to change over two $^1/_8$-in. thick bearing plates with undercut grooves running lengthwise of the piece, as well as two intricate pinwheels about 2 in. in diameter. All these molded parts are shown in Figs. 8 and 10.

The job was made more difficult in the molding operation by the selection of a medium blue phenolic material. If the register had not had several parts, all of which had to match perfectly in shade, there would have been no difficulty. However, as most molders can appreciate, a blue phenolic (which by its nature must be heavily loaded with inert material) is very susceptible to changes in shade, which may be brought about by slight variations in mold temperature or curing time. When this was further complicated by having several different molds, running at different cycles, the problem of exact color matching in the different parts became very difficult.

Compression molds were constructed for all these pieces with the exception of the pinwheel. Due to the need for a minimum of flash and a maximum of accuracy, a 2-cavity transfer mold was made for this part. Figure 11 shows the mold design. Note how pin "B" is undercut. This pin performs two functions: first, it molds the shaft hole, and

ALL PHOTOS, COURTESY KURZ-KASCH, INC.

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1—When this stamped aluminum housing for a portable register became a war casualty, the unit was engineered for plastics. 2—The light weight, strength and dimensional stability of the phenolic material selected add to the machine's utility. The fine blue color and the smooth, glossy surface enhance its sales appeal

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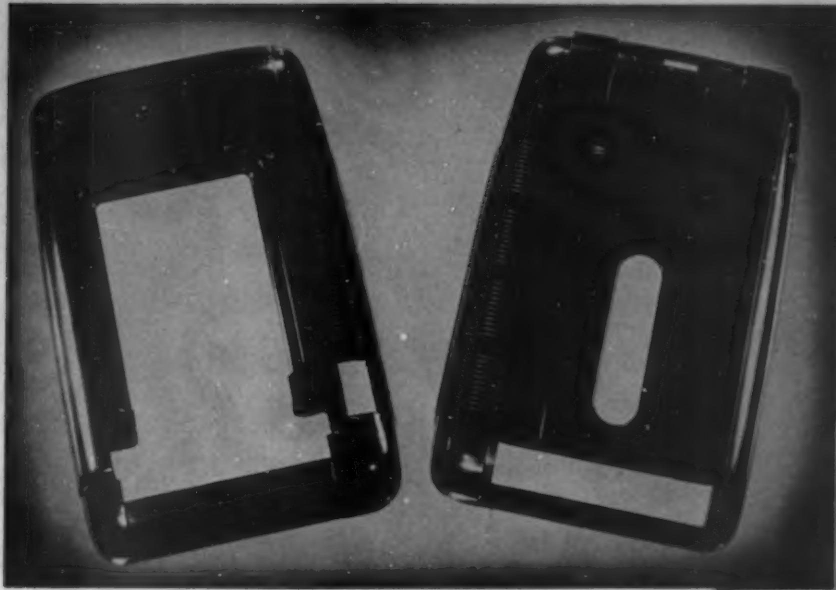
3—Two-cavity transfer mold designed for the complicated pinwheels shown at the right of Fig. 10. 4—After bearing plates are cured in this unique 2-cavity compression mold, the U-shaped handles slide them out of the cavities, which are of the open-end variety. 5—Single-cavity compression mold takes the lower half of the housing. 6—The same type of mold for the top half of the housing, here shown mounted in the press. 7—Both halves of a group of compression molds used for the smaller pieces of the 10-part register



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8—Top and bottom halves of the register housing after fins have been removed and the parts polished. 9—The assembled plastic housing shown in the open or loading position. 10—The register's small plastic parts ready for assembly. 11—Section through the center of the 2-cavity transfer mold for the pair of plastic pinwheels

second, it pulls the molded piece as well as the sprue out of the top cavity as the mold opens. With so large a proportion of molded area in the top cavity, it would be next to impossible to get the piece to stick in the bottom unless some device such as the undercut pin were used.

Inasmuch as the transfer molding does not lend itself to top knock-outs, it can be seen that some method of locking the piece in the lower cavity was essential. One finishing operation then cuts the shank to required length (see Fig. 8), thereby removing the sprue and the undercut position of the shaft hole. The slight fin around the piece at the split is then removed by buffing.

Another interesting mold is shown in Fig. 4. This is a 2-cavity mold for the bearing plates. As shown in Fig. 10, these plates have molded undercut slots. In Fig. 4, it will be seen that there are two square plungers which are in the back of the mold with a U-shaped handle in the front. After the pieces are molded and the mold opened, the bearing plates are held in the cavities by the undercut slots. The operator then pulls forward on the U-shaped handle and causes the square plungers to engage with the ends of the bearing plates, sliding them out of the cavities.

Note carefully this tool design, the open-end cavities which permit this method of piece ejection without loose mold parts. Naturally, some method of trapping the material in these open-end cavities had to be devised. This was cleverly done by constructing the force plugs with raised sections at the ends to trap the material in the cavity as the mold closes and pressure is exerted.

Figure 8 shows the bottom half of the case. Here the toolmaker had to do an accurate job, as the top and bottom of the case had to fit perfectly. A point of interest is that the cavity was machined on a duplicator.

The balance of the molds are shown in Fig. 10.

Many drill jigs were needed, as (*Please turn to page 118*)

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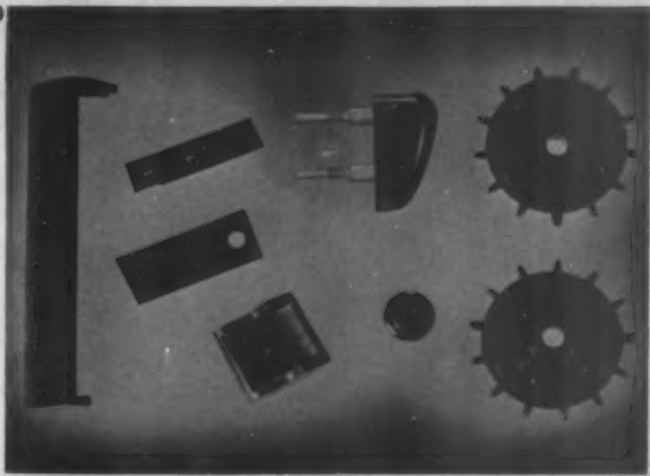

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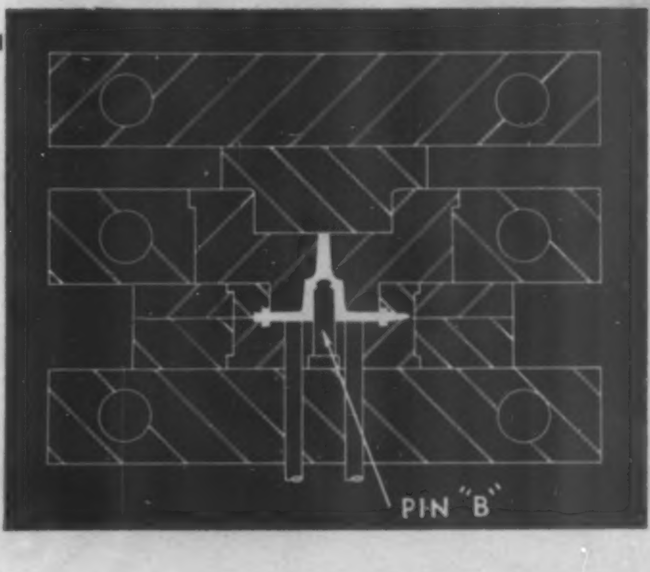

Laminated phenolic bearings

by K. T. MACGILL*

LAMINATED plastics have rapidly come to the forefront in the anti-friction field. Not, as might be expected, in small, light-load friction problems, but in the severe steel manufacturing and marine fields. The plastic bearing here described is a combination of a strong textile material and synthetic resins. The basic fabric is woven to combine both the benefit of wear on end grain of fibers and the strong binding together of these fibers through the length of the bearing. A phenolic resin is used as a binder and the resin impregnated fabric is formed into bearing shapes under heat and pressure.

One of the most important characteristics of this bearing is that it operates efficiently under the heaviest loads with water lubrication. Its use, therefore, effects important savings in oil, grease and labor costs. The bearing will, however, operate satisfactorily with oil lubrication, and in some instances may be used without either water or oil lubrication.

Resists extreme pressure

This plastic part will sustain a crushing strain of 32,000 lb. to 36,000 lb. per square inch. The permanent set under a load of 20,000 lb. per sq. in. is less than .0085 in. (eight and one-half thousandths of an inch). A high grade babbitt would set between .070 to .100 in. (seventy to one hundred thousandths of an inch) when tested under similar conditions. Bearing bronze similarly tested shows a permanent set of .0113 inch. The laminated plastic bearing has sufficient elasticity to absorb shocks without cracking and yet is so hard that even in mill operations, when rolling very thin gages of steel or brass where the rolls are in contact with each other, there is no difficulty in holding the gage. It has a dual character in regard to hardness. While it will only Brinell between 30 and 40 under a 500 kilogram load, it will scleroscope about 70 to 85. A hardened tool holder bit scleroscopes about 60.

Low coefficient of friction

It is this extreme surface hardness which gives laminated plastic bearings their low coefficient of friction. A representative steel manufacturer recently tested the bearing for coefficient of friction with water lubrication and compared it with that of a good grade of babbitt using oil as a lubricant. Under varying loads, ranging from heavy to light, the plastic bearing (water lubricated) developed a coefficient of friction as follows:

Rubbing speed 550 ft. per min. from .0198 to .0075
Rubbing speed 425 ft. per min. from .0227 to .0160
Rubbing speed 280 ft. per min. from .0236 to .0175

Babbitt (oil lubricated) performed as follows:

415 ft. per min. from .0654 to .0705
280 ft. per min. from .0516 to .0678

Babbitt (water lubricated) performed as follows:

405 ft. per min. registered .110

These figures show that the plastic bearing with water develops about one-third the friction (*Please turn to page 112*)

* Joseph T. Ryerson & Son, Inc.

1—Surface hardness of water-lubricated bearings made of laminated phenolic material gives them a low coefficient of friction. 2—Plastic bearings in a structural mill lasted 8 times longer than babbit bearings

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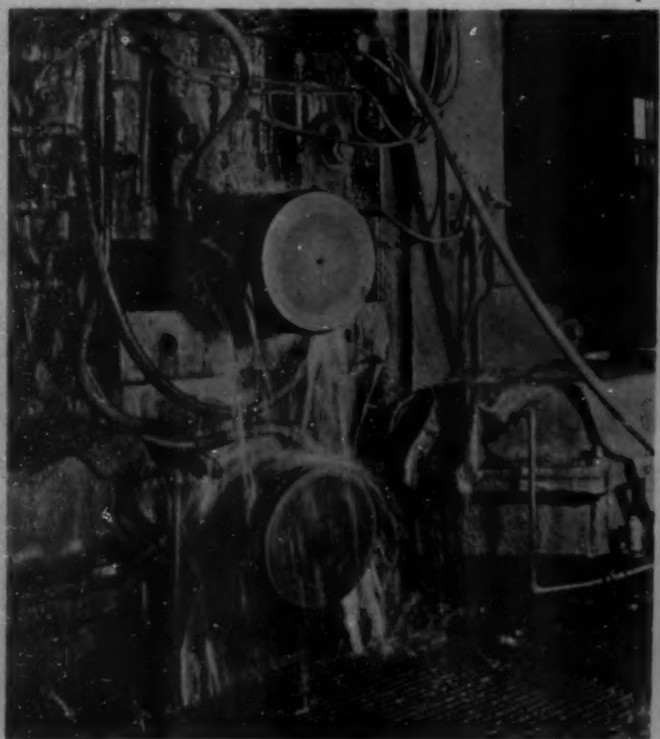

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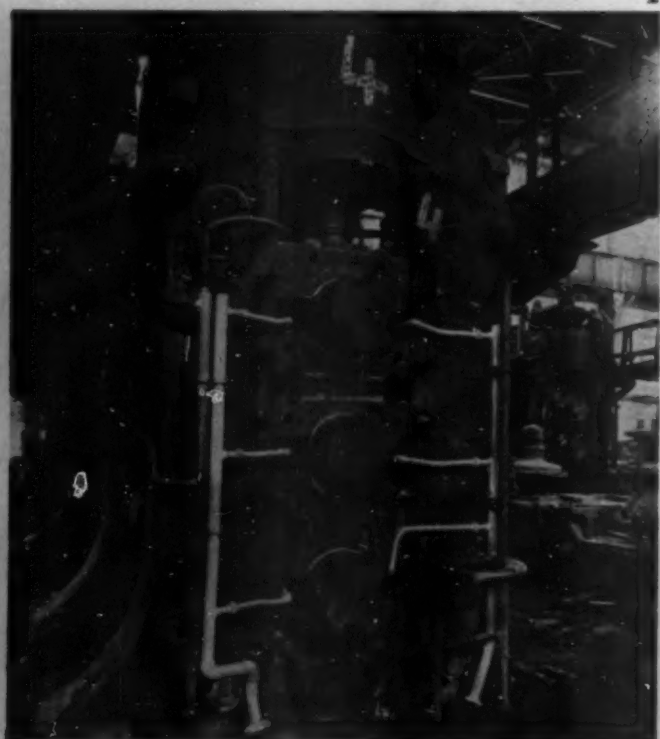

Extrusion on the way?

It's HERE!

On the record, the extrusion of plastics has "come of age." More than 50 manufacturers are today successfully extruding thermoplastics for war uses—using such materials as:

Acrylic Resins	**Vinyl Resins**
Styrene Resins	**Ethyl Cellulose**
Vinylidene Resins	**Cellulose Acetate**

Cellulose Acetate-Butyrate

Engineering service, pioneered in this field by National Rubber Machinery Company, and perfected by actual trial runs in its modern Pilot Plant, has served to eliminate guesswork and costly delays. Machines are built for the specific plastic and the needs of the job. By changing the production characteristics, or by selecting suitable non-corrosive materials, production is speeded up and operating costs reduced.

Almost any shape or cross-section can be produced by extrusion, continuously, economically and with practically no waste. That's the reason more and more National extruders are being engineered and installed for production of war-essential plastics. That's why many other farsighted fabricators are laying their post-war plans to include the extrusion of plastics for architectural shapes, cabinets, furniture, venetian blinds, decorative wall strips, borders for flooring, tubing, cylindrical containers of small diameter.

If you want complete facts on plastics extrusion, a National engineer will be glad to tell you of actual installations, discuss the possibilities for your product, and arrange for a trial production run in our Pilot Plant.

Plastics Division

NATIONAL RUBBER MACHINERY COMPANY

General Offices: Akron, Ohio

Cold molded preforms look like biscuits, break apart just as easily

Cold molding impact material preforms

One inexpensive method for making preforms of impact materials is to cold mold them in sets of six. No tamping or stuffing is necessary to get loose material into preform mold

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As impact materials are coming more and more to the front in every molding plant, one of the prime problems of molders becomes the development of an inexpensive method of making preforms of this type of material. Because preforming machines which are used for ordinary materials are not suitable for making high impact preforms, some special method of handling them must be found.

In many cases, the use of preforms is unnecessary, as molds have enough loading space for the impact material to be loaded without preforming. In other cases, however, this is not the fact. An example is a molded part which has previously been made from woodflour material and for which, due to added strength being necessary, impact material has been substituted.

Preforms permit the material to be preheated, thus driving off moisture. They facilitate the speedy loading of a mold. As they do away with a great deal of the messy weighing of loose molding powders, they permit a much cleaner area in the neighborhood of the press.

In the past, molders have merely used simple, single-cavity dies for preforming impact material, although the cost of each preform is high, and the production per press is low. One reason for the high cost of these singly made preforms is that generally the material is carefully weighed for each preform. However, no matter how carefully the material is weighed, the molder will usually insist upon weighing the preform itself before loading the mold.

One molding company has gone a very long way in reducing the cost of their preforms by making six at once (see photograph) and cold molding them. Because these preforms are nearly cut through, they break off one from the other like biscuits.

The material is not carefully weighed for each load, but an approximate weight is attained volumetrically by using measuring containers of various sizes. Although this method takes much less time than weighing the material, it is true that it does not give an exact weight preform. On the other hand, if an error is made of 12 grams in a load, for example, it will be seen that the error per preform will be but $^1/_6$ of 12 grams, or only 2 grams.

When these biscuit type preforms are given to the hot molder, he merely breaks off one or two of them, according to the weight he desires, and carefully weighs these preforms before loading them in the mold. As a general rule, a hot molder, due to the length of curing time, has ample opportunity to do this weighing without slowing down the molding cycle.

Of course, preforms are made for each specific job, and an attempt is made to hold the preforms as nearly as possible to the required weight. However, (*Please turn to page 118*)

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1—*Group of miscellaneous parts machined from polystyrene.* 2—*Graph showing relation of cost to quantity of machined and injection molded polystyrene parts.* 3—*Hypothetical part to be made of polystyrene*

Fabrication of polystyrene

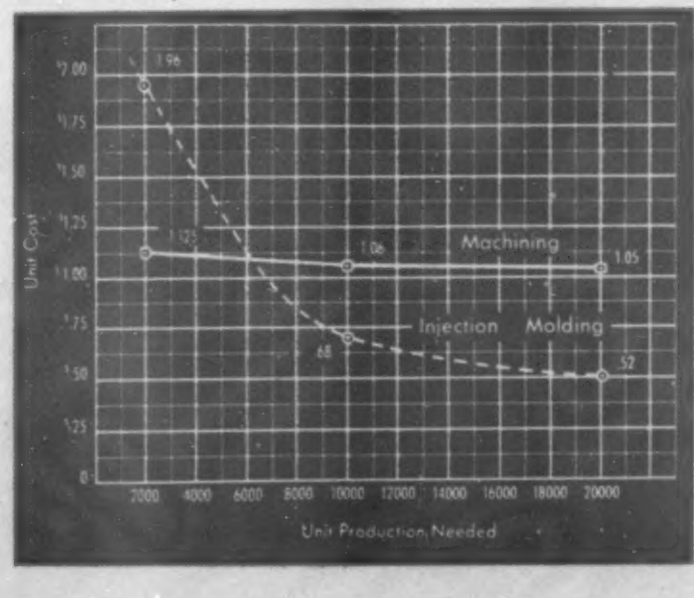
by H. E. GRIFFITH*

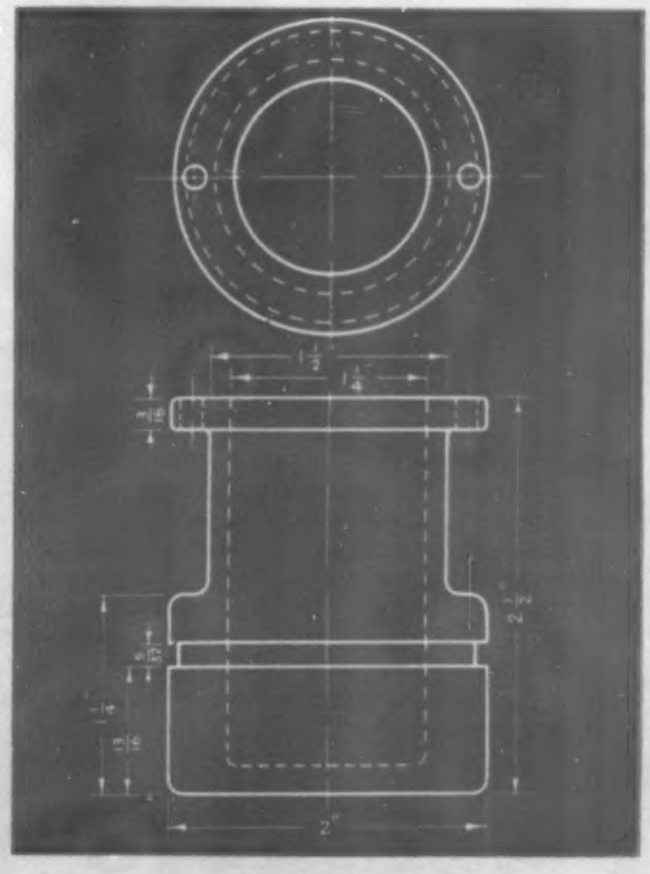
IN wartime, as at no other time, the question of machining from stock material vs. molding the final article becomes of utmost importance to the design and production engineer. When to machine and when to mold may be determined after careful consideration of factors which are frequently not evaluated properly. With polystyrene, the logical method of forming where quantity production is essential is usually injection molding. In those cases where the units weigh in excess of 2 lb., special molding techniques may be employed. However, machining often has definite advantages, even where injection molding is ultimately adopted. Machining is often advisable before starting injection molding. This is particularly true with units being designed for use in electronic and radio devices where frequent change of design in the early stages makes mold costs prohibitive.

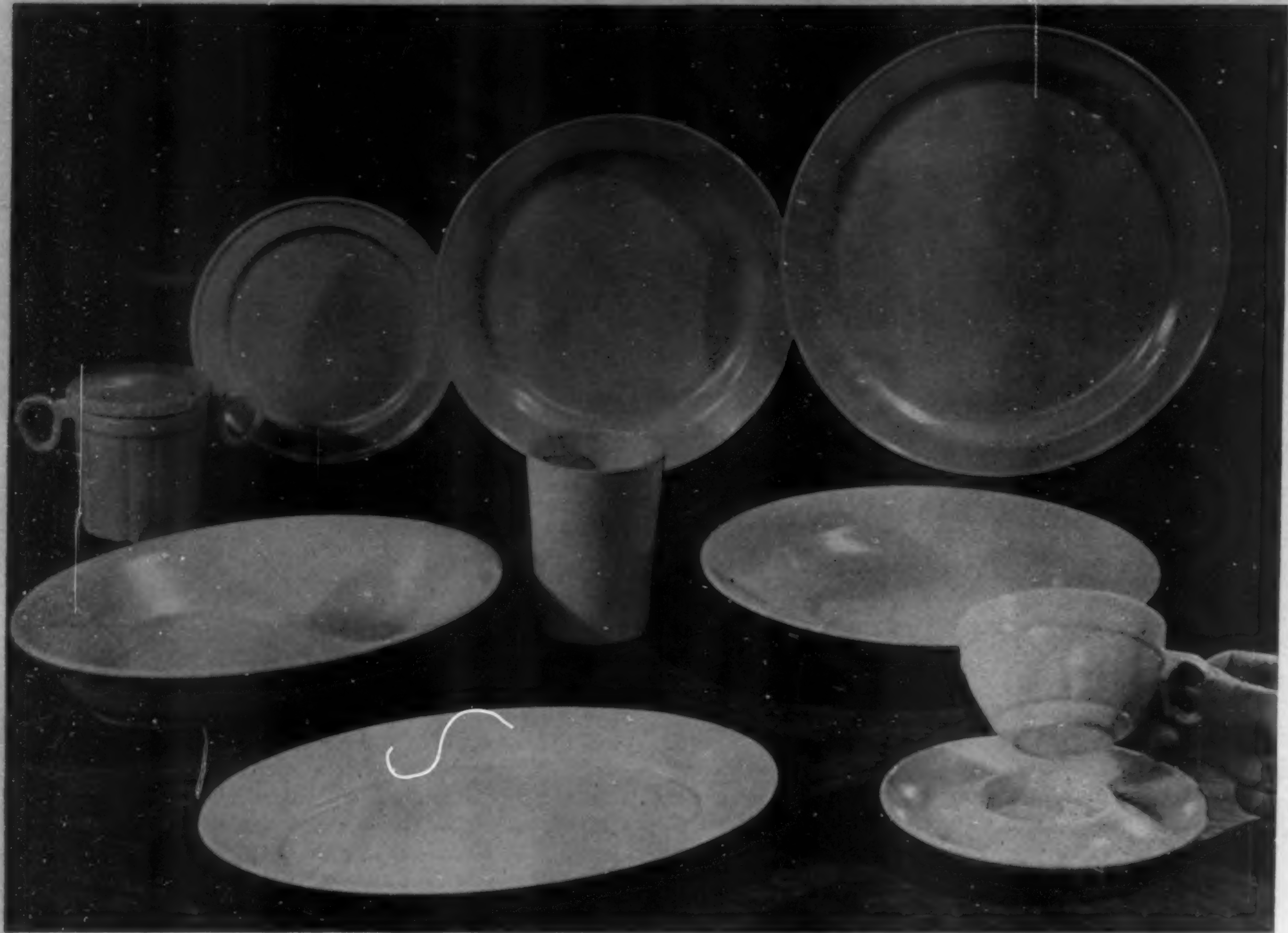
Early experience with the machining of polystyrene shapes led to great difficulty because of cracking of the machined pieces. However, research was continued in this field, and now one company produces a stabilized polystyrene stock that is extremely resistant to cracking. Use of this new stabilized styrene puts it for the first time in a class with the cellulosics and phenolics insofar as machinability is concerned. It is not to be assumed from this statement that one may machine polystyrene sheet, rod or tube without fear of failure. The technique of handling is still somewhat complicated; but a skilled machinist, once he has become familiar with the material, can turn out an amazingly high percentage of good units by using fully automatic screw machines.

The factors to be considered in determining whether to machine, injection mold, or use a (*Please turn to page 122*)

* Plax Corporation.







Attractive melamine tablewear for use aboard U. S. Navy vessels won't crack, has no odor, absorbs little water

Reducing breakage in the Navy

FOR many years, crockery was the standard equipment for tableware on most naval vessels. Approximately two years ago the British found that, due to the necessity for repelling torpedo plane attacks, a ship's guns had to be depressed to a level about parallel to that of the ocean. Thus when the guns were fired, the ship skidded sideways much more than normally, resulting in heavy breakage of all fragile articles aboard. Practically no crockery remained in a usable condition after such naval engagements.

The British, therefore, changed immediately to molded urea tableware. This standard urea material, although unsatisfactory in many respects, was the best available at the time.

During the battles in the Java Sea, United States naval vessels suffered the same sort of breakage calamities, and the Bureau of Ships ordered an immediate change to more serviceable tableware.

Choosing the material

For several years the commercial airlines have been using urea dishes, which the passengers seemed to find entirely satisfactory. However, the airlines were in a position to discard any pieces that became stained or cracked. The Navy, of course, cannot afford to throw away dishes for such reasons, and therefore wanted no material that cracked or discolored.

As a possible solution, the new melamine resins were considered, and alpha-cellulose filled melamine-formaldehyde was used by a New England plastics company for molding some experimental pieces. This material was much harder, stronger and more stain-resistant than urea and its water absorption was very low. Specifications were then written by the Bureau of Ships for plastic tableware which would have the properties of this new melamine material. Some of these specifications are as follows:

Specifications

Resistance to boiling water—The tableware shall be placed in boiling water for 30 minutes, removed, and allowed to stand for 1 hour at room temperature. This cycle shall be immediately repeated 3 times in order to give a total of 4 such cycles. The tableware shall be allowed to stand for 48

hours in air at a temperature of 77° ± 2° F. and a relative humidity of 50 ± 2 percent.

The tableware shall not contain cracks or show surface chalking after being subjected to this test.

Resistance to staining—The tableware shall be placed for 30 minutes in a covered vessel containing boiling coffee, made by adding 1 tablespoonful of ground coffee to each 12 ounces of water, thoroughly rinsed with tap water, dried with a cloth, allowed to stand at room temperature for 4 hours, and examined for staining by comparing with an untreated specimen.

The tableware shall then show no staining or appreciable discoloration—that is, a change in color which is readily perceptible without close examination.

Water absorption—The tableware shall be dried in an oven for 24 hours at 50° ± 3° C., cooled in a desiccator for 15 minutes, and immediately weighed. The conditioned specimens, resting on edge, shall be entirely immersed for 24 hours in water maintained at a temperature of 25° ± 2° C., removed from the water one at a time, all surface water wiped off with a dry cloth, and weighed immediately. This is the wet weight. The specimen shall be replaced in the oven at 50° ± 3° C., and heated for 24 hours, cooled in a desiccator for 15 minutes, and immediately weighed. This is the reconditioned weight. The percentage of water absorbed is calculated as follows:

$$\text{Water absorbed, percentage} = \frac{\text{Wet weight—reconditioned weight}}{\text{Conditioned weight}} \times 100$$

The percentage of water absorption shall be no more than 2.0 percent.

Odor—The tableware shall be two-thirds immersed in boiling water and the container immediately covered tightly for 5 minutes. The molded bowls and cups shall be two-thirds filled with boiling water and immediately covered tightly for 5 minutes. The presence or absence of an odor shall be determined immediately upon removing the cover.

The tableware shall not give off an objectionable odor when so treated.

Planning the mold

Sample molds were then constructed by the company which had made the original experiments with the melamine material, and wall sections of items produced were tested. These wall sections had been molded in thicknesses varying from .050 in. to .090 in. so that a happy medium between strength and water resistance could be attained. This was necessary, as on thinner sections the center of the section was harder and had a higher resistance to water. Where it was thickened up, there was a slight soft section which tended to absorb moisture.

Finally a wall section of approximately .070 in. was decided upon. This gave ample strength to the wall and the small amount of water absorption was not detrimental to the functioning of the dishes. These pieces were designed for a maximum strength by reinforcing their edges. Although a second melamine resin combined with a chopped cotton filler was tried out and found to be stronger than the alpha cellulose material, it was not considered that this extra strength was necessary, and work proceeded with the compound originally selected. In addition, light color could not be obtained in the stronger material, which consequently did not produce so attractive a dish.

Designing the dishes

The design finally adopted by the Bureau of Ships provided for a maximum nesting of the pieces, which resulted in some shapes being slightly different from those found in standard tableware patterns. Another notable point in the design is that the flange on the plate is about half the width of that on a crockery plate. This made it possible to produce a plate 8 in. in diameter with the same well capacity as a standard 9-in. crockery plate. For the same reason, a 10-in. melamine plate has the same capacity as the standard 11-in. plate. The one exception to the narrow flange pattern is the soup plate, which was given an extra wide edge to guard against spilling. The cup and saucer design (below) has a unique non-drip and non-slip feature, which gives it a great advantage aboard ship: the cup nests into a depression in the saucer which is deep enough to allow the latter to be tipped more than 30° before the cup slips.

When the experiments had been concluded, production tools were immediately manufactured, and these sets of dishes are at the moment in production for all naval ships and shore stations.

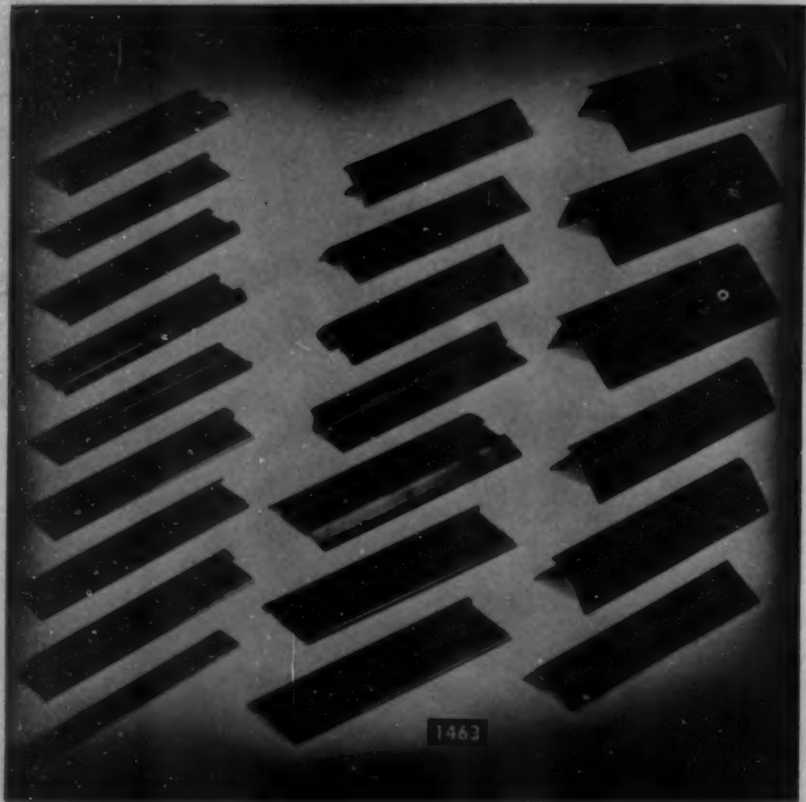
Some additional advantages which (*Please turn to page 122*)

As the ship rolls, the dishes slide—but this molded melamine saucer will have to tip more than 30° before the cup overturns. The strongest coffee won't stain or discolor it

Stock molds

SHEET ONE HUNDRED TWENTY-FIVE

Stock extruded shapes combine utility and beauty as edging for tables, furniture, counters, cabinets, kitchen and bathroom trim



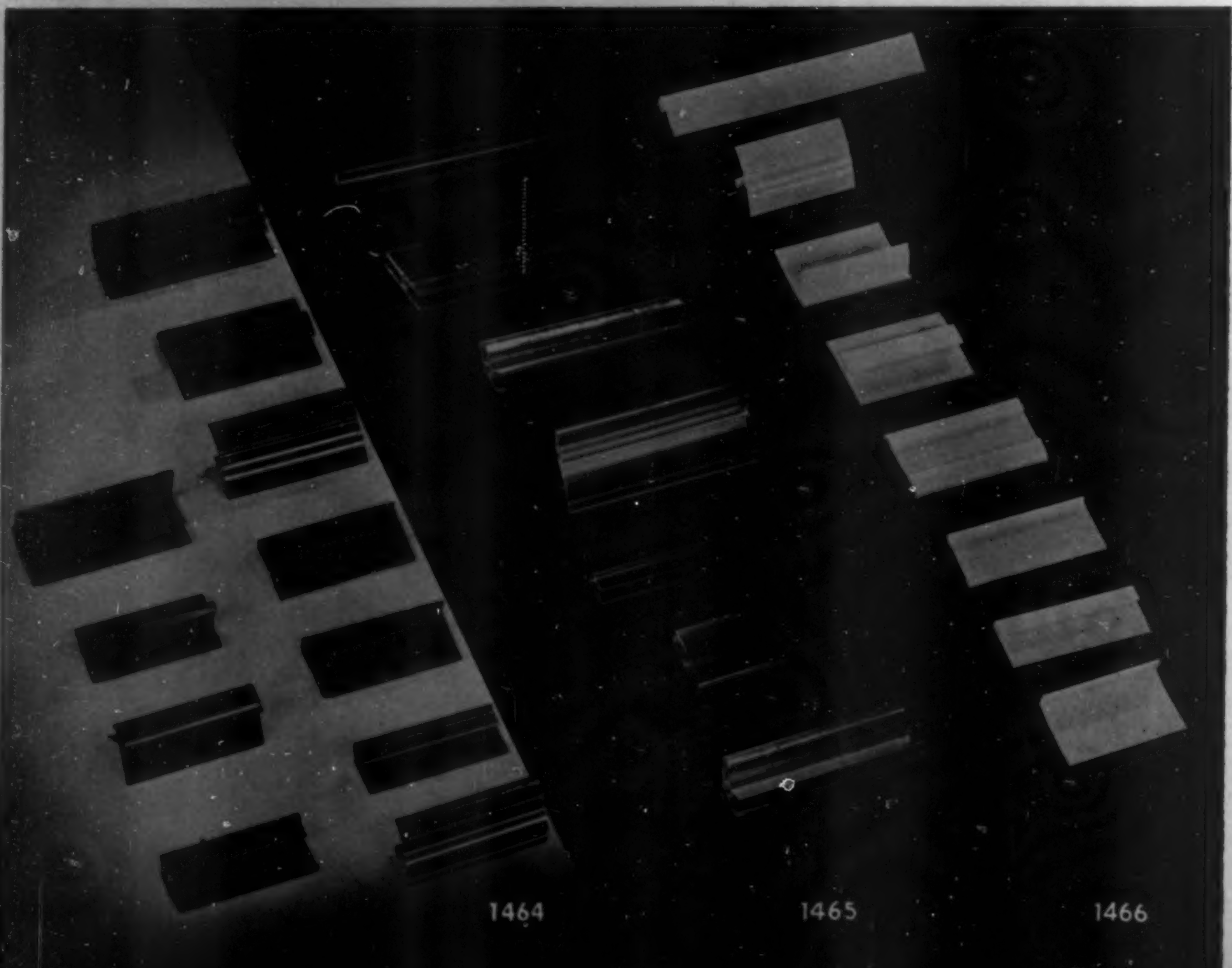
1463. Forms for edgings, nosings, cap molds, exterior and interior corners, division bars, etc. Colors: ivory, black, red, blue, green

1464. Shapes in straight 12 ft. lengths for use with flexible and rigid wall or counter covering materials. Used for cap, panel, inside or outside corners, cove, edging, nosing or insert nosing purposes. Colors: black, red, white. T-shape also in green

1465. Transparent strips for edgings and joints in display counters. Facilitate assembly of glass partitions and help prevent breakage. Shapes in "H," "U" and right angle sections

1466. Same as 1464, in white

Reprints of all stock mold pages published with complete index of suppliers are available to Stock Mold Service Subscribers, c/o Modern Plastics, Chanin Bldg., New York



Behavior of plastics under vibrations[1]

by B. J. LAZAN[2]

A new oscillatory-type testing machine was developed for determining the mechanical properties of materials under alternating torsional stress. The damping capacity and dynamic modulus of rigidity of both plastics and metals were evaluated by the use of this machine and studies are reported of how these properties are affected by sustained cyclic stress below the endurance limit and also at impending fatigue failure. A similar dynamic testing machine was built for applying alternating direct stress, and parallel studies were made under axial-loading conditions. The mechanical properties of selected materials in static tension, compression, and torsion were also determined to supplement the dynamic tests. The wide deviations observed between the static and dynamic moduli of elasticity for plastics are analyzed and are associated with the damping capacity of the material. The significance of these deviations, as related to the repeated constant-deflection type of fatigue test on plastics, is discussed. Experimental data on the damping capacities, dynamic moduli of elasticity, and some static mechanical properties are presented for mild steel, duralumin, and laminated-paper phenolic (grade X), laminated-canvas phenolic, and polymethyl methacrylate plastics.

In a large proportion of modern machine and structural members, vibratory forces are superimposed upon static loadings. These dynamic components of the resultant stress affect the mechanical behavior of the materials of construction and cause a reduction in their load-resisting properties. Higher speeds in present-day machinery and transportation have amplified the importance of dynamic forces as a factor in design. Studies made in England by Aitchison showed that 95 percent of the failures in automobile parts were caused by dynamic forces (1).[3] Hardly any machine-part failures investigated by Roos of the Swedish Materials Testing Laboratory could be attributed to static forces alone, 80 percent of the failures being caused by repeated stress, the remaining 20 percent involving impact.

Much research has been stimulated by the need for accurate knowledge of the dynamic mechanical properties of materials. However, most of this work has been confined to one phase of the general problem, i.e., that of evaluating fatigue strengths or resistance to fracture under alternating stress. Although the fatigue strengths are, perhaps, the most valuable properties of materials, other dynamic characteristics are significant in many engineering applications. For example, under the forced resonant vibrations excited by wind, a copper overhead cable of low tensile and fatigue strength may be more durable than a light metal alloy of higher strength but lower damping capacity (12). Similarly, an engine crankshaft or an airplane propeller of high damping-capacity material may outlast another of low damping capacity, even though its static and fatigue strengths may be relatively low.

The dynamic mechanical properties which affect the serviceability of structural and machine parts follow:

(a) The fatigue strengths define the points of fracture.

(b) The damping capacities are associated with the peak stresses caused by near resonant vibrations, the heat produced in a material during cyclic stress, the noise produced by meshing gears and other machine parts, "dynamic ductility," the "whirling" of rotating shafts, and the vibration insulation of a material.

(c) The dynamic moduli of elasticity influence the natural frequencies of vibration and the alternating stress caused by a known cyclic strain.

(d) The effects of superimposed vibratory stress on the stress-strain and strain-time (creep) relationships are important in many engineering designs where excessive deformation constitutes failure. In heat engines, for example, very small clearance must be maintained for efficient operation.

The special apparatus and methods developed for this work have been used to secure a limited amount of data on all of the dynamic properties mentioned. However, this paper is restricted to a discussion of the damping capacities and dynamic moduli of elasticity of materials under both pure torsional and pure longitudinal vibrations.

Apparatus and technique

Basic experimental arrangement. The basic experimental setup is illustrated in Fig. 1. The oscillator O is attached to the bottom of test specimen S by means of gripping chuck C_b. Chuck C_t, securely attached to massive frame F, supports the specimen-oscillator combination. Since frame F is rigid and massive, the top of the specimen is practically fixed and the specimen-oscillator assembly behaves as a system with a single degree of freedom subjected to the forced vibrations of oscillator O. Vibrations at any proximity to resonance may be produced and controlled.

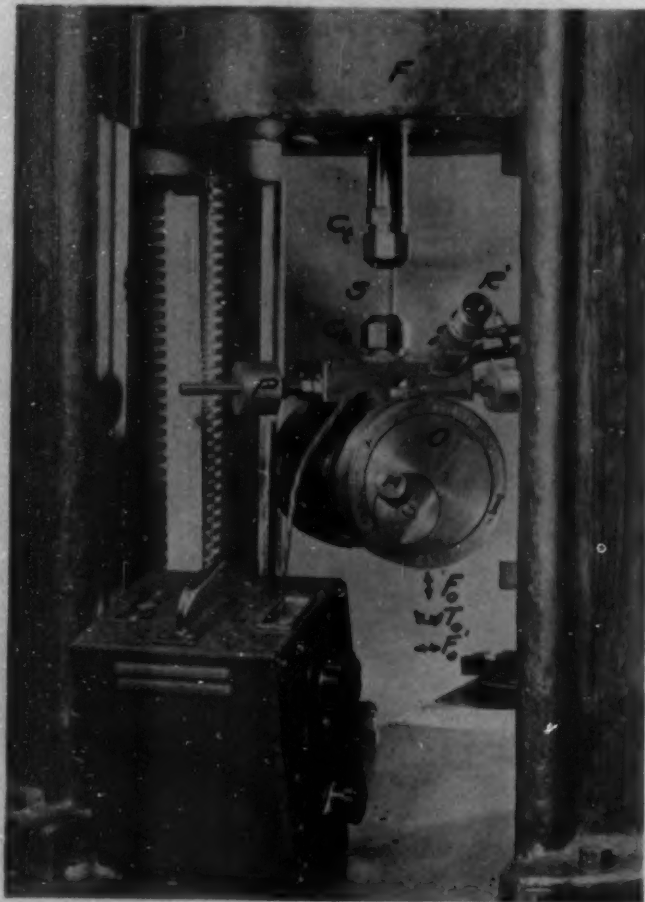
The controlled vibratory stress induced in the specimen constitutes a fatigue test. This cyclic stress is determined from inertia force produced by the vibrating mass. The dynamic moduli of elasticity are computed from the frequency of the resonant or near resonant vibrations. The damping capacities are evaluated from the knowledge of the oscillator force and amplitude of vibration at or near resonance. A quantitative analysis of these three properties, with equations, appears in section D of the appendix. (*Please turn to next page*)

[1] This paper was presented before the Rubber and Plastics Subdivision of the Process Industries Division of the American Society of Mechanical Engineers in Cleveland, Ohio, June 8, 1942, under the title "Some Mechanical Properties of Plastics and Metals under Sustained Vibrations," and is published here in abridged form by permission of that Society.

[2] Assistant Professor of Engineering Mechanics, The Pennsylvania State College.

[3] Numbers in parentheses refer to the Bibliography at the end of the paper.

Dynamic tests under many types of stresses may be performed with this apparatus. If the oscillator O, in Fig. 1, is adjusted to produce alternating torsional couples T_o, the specimen-oscillator system vibrates as a torsional pendulum and induces alternating shearing stress in the specimen. If the oscillator is set to produce alternating longitudinal forces F_o along the axis of the specimen, then direct dynamic stress results. Lateral forces F_o' cause the specimen-oscillator system to vibrate as a cantilever beam and thereby subject the specimen to alternating bending stresses. The apparatus is therefore capable of producing the three most common types of dynamic stresses, i.e., tension-compression, torsion and bending, in pure form. Any combinations of these three types of pure vibrations may also be produced by the "hypocyclic oscillator" which will be described under that heading.



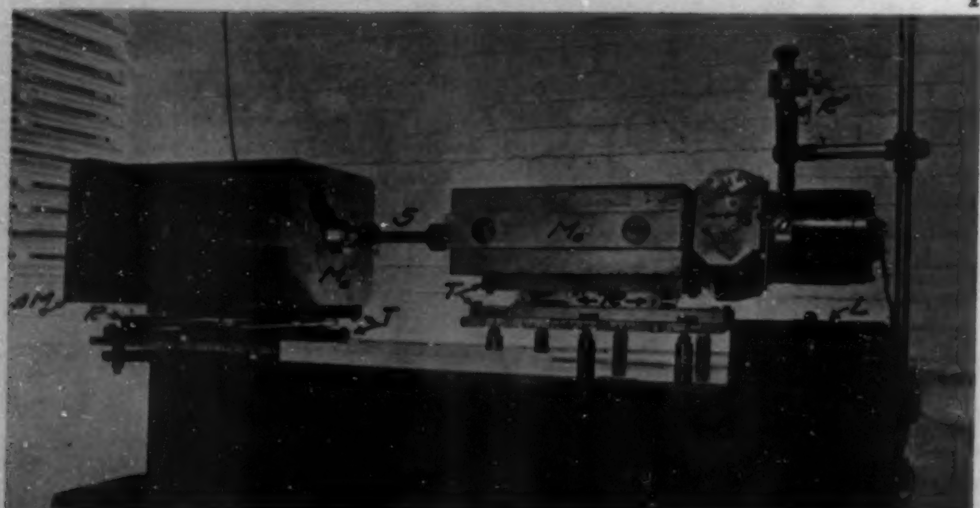
The vertical specimen arrangement, Fig. 1, is satisfactory for most torsional-vibration tests and low-capacity direct-stress tests. However, when large specimens are tested under direct dynamic stress, the vibration of the supporting frame becomes quite pronounced. Not only are these frame vibrations troublesome, but they signify a source of energy loss which would distort the data on the damping capacities and dynamic moduli of elasticity. Therefore, when the dynamic forces involved are large, a variation of the basic experimental arrangement to be explained in the following section is employed.

Horizontal arrangement. Fig. 2 illustrates a direct-stress dynamic testing machine, in which the specimen S is in a horizontal position. The roller R and rail T arrangement enable the masses M_o and M_o' to move freely in a horizontal direction. During the vibration, induced by the oscillator O bolted to the mass M_o, the two masses always moved in opposite directions at any instant of time. The nodal position of the vibration, which always remains stationary, is near the center of the specimen. Parts on opposite sides of the nodal section vibrate in antiphase, and the specimen is thereby subjected to alternating direct stress. The rails and rollers are made of an alloy steel, heat-treated to a Brinell hardness exceeding 500, and ground to a smooth accurate finish. The extreme hardness reduces the energy loss caused by hysteresis damping at the rail-roller contacts, and the ground finish minimizes the vibrational energy radiated through the rails to the floor.

This horizontal setup has the following important advantages over other fatigue machines, especially when concerned with high-capacity work.

1. No massive frame or other structural units are required. The only parts subjected to the full alternating force are the specimen and its gripping chucks. The floor and rails need support only the constant dead weight of the apparatus, and a special foundation is not required.

2. Slight difficulty is encountered because of eccentric loading of specimens. This eccentricity, which is usually a significant source of error in many direct-stress fatigue machines, may be caused by the nonlinear motion of the specimen chucks, such as occurs in a beam-type machine, or an eccentric center of pressure of the applied load. The fatigue machine, shown in Fig. 2, reduces this and the foregoing causes of eccentricity because all the motions involved are linear. Furthermore, all elements of the machine are sym-



1—Universal dynamic testing machine. 2—Horizontal type dynamic testing machine for direct alternating stress

metrical about the axis of the specimen and are subject to easy and accurate adjustment for concentricity.

3. The room available for the test specimen or structure is unlimited. The floor rails may be moved apart in order to accommodate a specimen of any length, and, with suitable pedestals for raising the rails, specimens of any width or height may be inserted.

4. If the vibrating system is operated near resonance, large amplifications in the applied force may be realized. Amplification factors exceeding 200 have been observed in this machine. A new ±150,000-lb. direct-stress fatigue machine of this horizontal type which utilizes the resonant-vibration principle is now under consideration.

5. The damping capacities and dynamic moduli of elasticity may be evaluated.

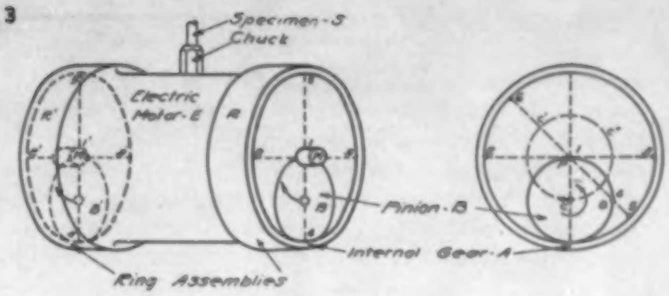
It may be desirable to replace the left-hand weight M_o' by a fixed support, but dynamic forces will then be transmitted to the foundation. For low-capacity machines, it may be more convenient to hang the mass M_o from wires, rather than to support it on rollers. An experimental arrangement, similar to Fig. 2, may also be used for large-capacity torsional-fatigue tests. In this case the masses, M_o and M_o', which may be flywheels, would be supported by bearings concentric with the specimen. The two masses would vibrate torsionally in antiphase about the axis of the specimen and thus subject the specimen to alternating torsional forces. This experimental arrangement was not used, however, since the basic setup of Fig. 1 was satisfactory for all the torsional work undertaken.

Centrifugal-force oscillator. The oscillator in the horizontal arrangement of Fig. 2 employs the centrifugal force of eccentrically supported rotating masses. In this oscillator, which utilizes an old principle (9, 10), but is of a new compact design, an eccentric mass is attached to the ends of each of two shafts rotating in opposite directions. If the eccentrics are set as shown in Fig. 2 (where only one end of each shaft is visible) the vertical components of the centrifugal force mutually cancel each other and leave only horizontal sinusoidal force F_o. By turning two diagonally opposite eccentrics through 180°, the oscillator can also produce pure torsional vibrations. As the project expanded in scope, certain limitations appeared in the centrifugal-force oscillator, and the hypocyclic oscillator was therefore developed.

Hypocyclic oscillator.[4] The principle of this newly developed oscillator is illustrated in Fig. 3. Pinion B meshes with and revolves within stationary internal gear A so that the center of the pinion moves in the circular path C-C'-C''. During its clockwise revolution, pinion B rotates about its own center C counterclockwise. Since the diameter of the pinion is one half that of the internal gear, any point on the pitch circle of pinion B moves with linear sinusoidal motion. Thus point P moves along the horizontal straight line 1-2-1-3-1 and any general pitch point G moves along inclined line 4-6-4-5-4. If a small mass (see M in Fig. 3) is attached at any pitch point, such as P or G, it produces linear sinusoidal force along the direction of the motion. Electric motor E has a flange mounting and shaft extension on either end, to which is attached identical ring assemblies R and R'. The motor drives the rotating disks which carry pinions B and B', and the eccentric masses M and M' move with linear sinusoidal motion. The direction of the straight-line motions of these masses and the corresponding line of action of the linear

[4] The patent on this oscillator, which is pending, has been licensed to The Baldwin Southwark Corp., Philadelphia, which company is producing it commercially under the name of the "Lazan Mechanical Oscillator."

3



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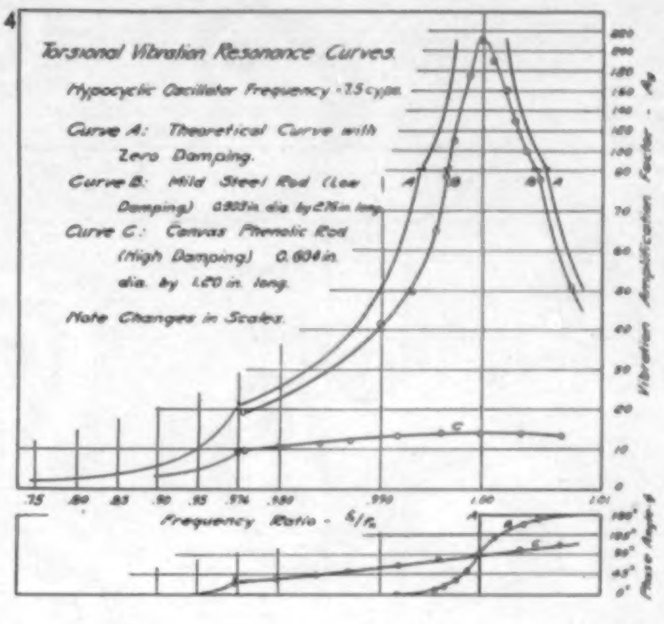


3—*Diagram showing principle of hypocyclic oscillator.* **4**—*Torsional vibration resonance curves*

sinusoidal force are adjusted by meshing the proper teeth of pinion B and internal gear A.

The hypocyclic oscillator illustrated in Figs. 1 and 3 can produce any state of pure or combined dynamic force merely by proper presetting of pinion B within gear A; for example:

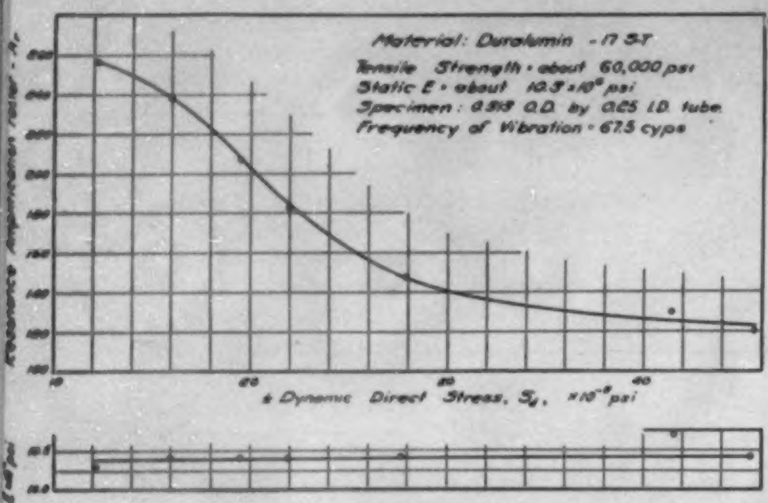
(*a*) To produce alternating bending stress in the test specimen or structure S, Fig. 1, pinions B and B' are set as shown in Fig. 3 so that mass M and M' oscillate horizontally in phase in paths 1-2-1-3-1 and 1′-2′-1′-3′-1′, respectively.

(*b*) To produce longitudinal vibrations or alternating direct stress, pinions B and B' are set so they mesh at 3 and 3′, respectively, and the inertia masses remain in the position shown. Masses M and M' therefore move vertically in phase in paths 1-4-1-5-1 and 1′-4′-1′-5′-1′, respectively.

(*c*) To produce torsional vibrations pinion B is meshed with gear A at point 5 so that mass M and pinion B' remain in the position shown in Fig. 3. Masses M and M' therefore move horizontally in antiphase in paths 1-3-1-2-1 and 1′-2′-1′-3′-1′, respectively.

(*d*) A state of combined torsion and bending, combined torsion and direct stress, or combined bending and direct stress in any relative magnitude is produced by setting the pinion so the inertia masses move in a predetermined inclined direction and/or at suitable phase angles.

To regulate the magnitude of the force produced by this oscillator, any one or several of a geometric series of masses similar to M may be screwed in place. In a new design, not used in the present work, the force may be continuously regulated while the oscillator is in operation. The frequency of



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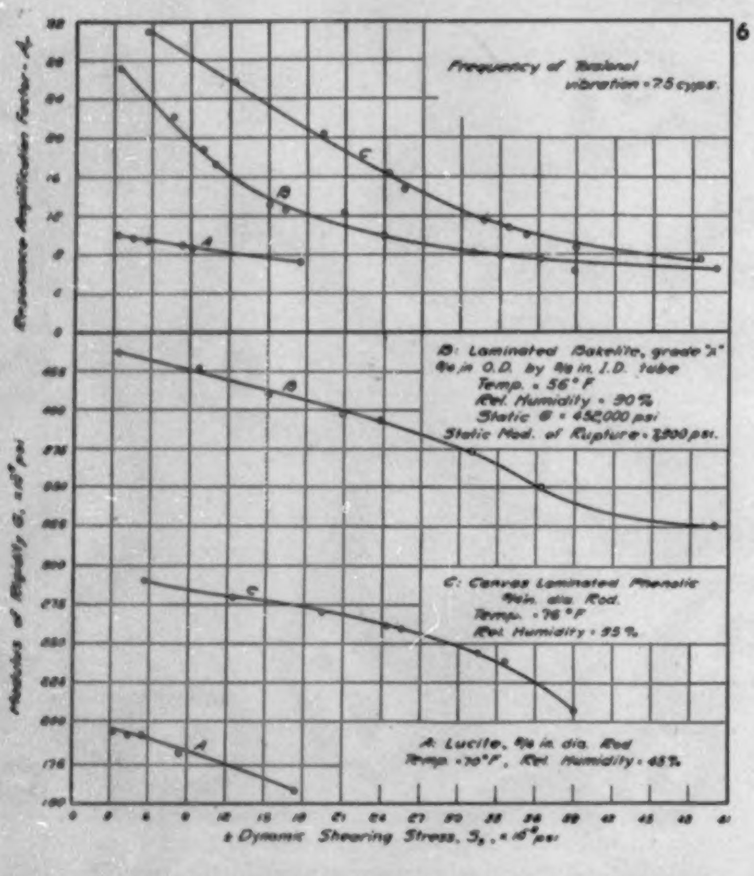


6

5—Resonance-amplification factor and dynamic modulus of elasticity of duralumin under longitudinal variations. 6—Resonance-amplification factor and dynamic modulus of rigidity of plastics under torsional vibrations

oscillation may be altered, even if the motor E has a constant speed, by inserting suitable change gears between the motor and ring assembly. The hypocyclic oscillator weighs about 50 lb., including its $^1/_8$-h.p., 1800-r.p.m., synchronous electric motor, which alone weighs 25 lb. The latest design can produce forces exceeding 2000 lb., or torques greater than 10,000 in.-lb.; however, a larger motor may be required for some applications.

Use of near-resonance vibrations. The specimen-oscillator vibrating systems, shown in Figs. 1 and 2, may be operated at any proximity to resonance. Near-resonance vibrations were used for two reasons:

(*a*) To permit a more accurate determination of the damping capacities and the dynamic moduli of elasticity.

(*b*) To increase the force-producing capacity of the dynamic testing machine (11). The amplitude of forced vibration produced by an alternating force of constant magnitude (such as the force of an oscillator) may increase more than 200 times as a vibrating system approaches resonance. This vibration amplification is illustrated in Fig. 4, and factor A_v and other symbols are defined in the appendix.

Synchronous-motor drive for resonance control. Because of the steepness of the resonance curve near resonance, an oscillator motor with excellent speed regulation is required, in order to control reasonably the force on the test specimen. For example, experimental curve B of Fig. 4 shows that for a material possessing low damping capacity, a 1 percent change in oscillator frequency near resonance may cause a 500 percent change in amplification factor A_v and the stress in the test specimen. If the vibrating system is operated away from resonance, or if high damping capacity is present in the system (see curve C in Fig. 4), then the amplitude of vibration does not vary so critically with oscillator frequency. The speed of the usual electric motor is influenced by such factors as variation in motor load, line voltage and heat transients, which disturbances often cause a speed fluctuation exceeding 5 percent. With special apparatus it is possible to reduce this fluctuation to within 1 percent in some cases. With the ordinary synchronous motor, however, the speed remains essentially constant.

Method of tuning vibrating system to resonance. Since the oscillator frequency f_o can be changed only in steps with change gears, the natural frequency f_n must be altered to tune the vibrating system to resonance. The natural frequency of the torsional vibrating system of Fig. 1 is adjusted by changing the moment of inertia I_o of the oscillator assembly by turning poise P on the threaded rod. The natural frequency of the longitudinal vibrating system of Fig. 2 is changed by adding masses $\Delta M_o'$ to the left end of M_o'. A phase indicator is built in each oscillator (see I, Fig. 1) to show the phase angle between sinusoidal force of the oscillator and displacement of the vibrating system. The position on the resonance curve, Fig. 4, may be determined by reading this phase indicator as explained in the following section.

Measuring apparatus and technique. The amplitude of vibration of a body or of an ink spot on a specimen is measured by a microscope-stroboscope technique (see R' and L in Figs. 1 and 2). In many cases a light needle scratch is placed on the vibrating body and, under oblique white illumination, the path of motion can be seen and quickly measured microscopically, without stroboscopic light. To determine the phase angle of the vibration, the stroboscope is set at nearly twice the frequency of the vibration so that one spot on the oscillator generally appears to be two, always moving in opposite directions over the amplitude of the vibration. When the two spots cross, appearing as one spot, the vibration is at its mean position. At that instant, the phase angle is read on the phase indicator (see I in Fig. 1) illuminated by the same stroboscopic light.

Specimens and gripping devices. Nearly all tests reported in this paper were performed on uniform unmachined rods and tubes with outside diameters from $^1/_3$ to $^3/_4$ in. without fillets or specially machined test section. Standard collet chucks for turret lathe and milling machine[5] (see C_t and C_b in Fig. 1) were used to grip the test specimen. The friction bond between the

[5] The manufacturer of these chucks is the Universal Engineering Co. of Frankenmuth, Mich.

specimen and collet over $1^1/_2$ in. of specimen length was sufficient for these tests. One desirable feature of the collet-chuck grip is that it can accommodate as a test specimen any uniform tube and rod without specially machined ends or test section. This is advantageous because specimens are easier to make, long gage lengths may be employed, and plastic and other rods with special surface coatings may be tested in an undisturbed condition. The fact that very few fractures occurred at the grips is indicative of the effectiveness of the chucks in avoiding stress concentration.

Analysis and significance of test data

Experimental curves. Figs. 5 to 7 show the experimental data plotted with either direct or torsional stress as abscissas and with both the resonance-amplification factor A_r (analyzed in the following section) and the dynamic modulus of elasticity (discussed in a subsequent section) as ordinates. In Figs. 5 to 7 no attempt is made to illustrate the effect of cyclic stress on ordinates A_r and G, and the abscissa is the dynamic stress S_s or S_a for the torsional and longitudinal cases, respectively.

Resonance-amplification factor A_r. In the following discussion the terms "damping capacity" and "resonance-amplification factor" (a quantitative and reciprocal measure of damping capacity) are used in accordance with the definitions given in the appendix.

The resonance-amplification factor for the plastics of Figs. 6 and 7 is about $^1/_{10}$ that of metals. Thus for certain engineering applications, plastics may be superior to metals as illustrated by the following numerical example. If an alternating force excites resonant vibrations, the dynamic stress produced is the product of the resonance-amplification factor A_r and the magnitude of the exciting stress. Under direct stress the endurance limit of duralumin, a strong aluminum alloy, is about 15,000 p.s.i., at which stress the resonance-amplification factor, given in Fig. 5, is 242. Thus, if a duralumin structural member is subjected to longitudinal resonant vibrations, the magnitude of the exciting force cannot exceed (15,000/242) = 62 p.s.i. of cross sectional area. If this same structural member were made of canvas-laminated plastic (with an endurance limit of about 5000 p.s.i., at which stress factor A_r in Fig. 7 is 11) the exciting force could attain a value of (5000/11) = 464 p.s.i. of cross sectional area before fatigue failure would occur.

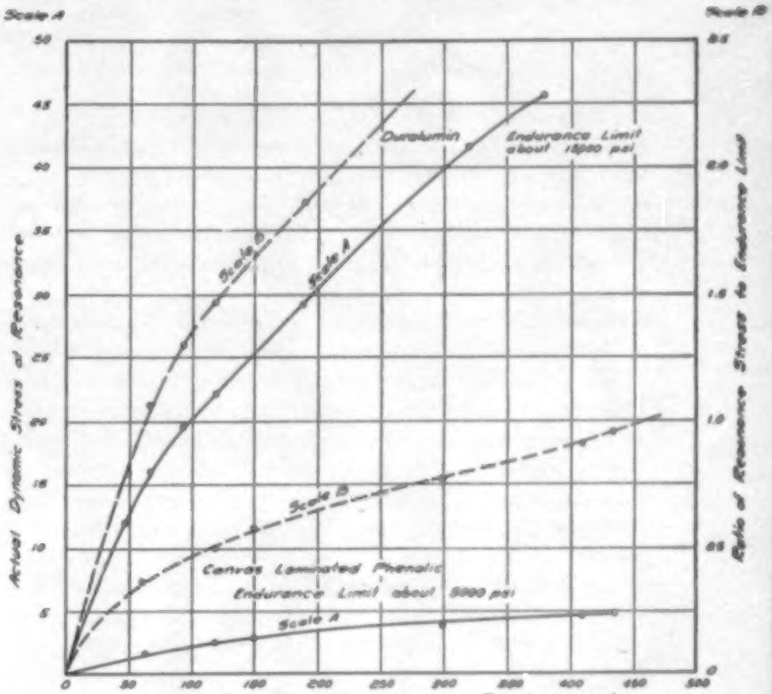
The significance of high damping capacity (or low resonance-amplification factor) in reducing resonant-vibration stresses is further clarified in Fig. 8, which is a replot of Figs. 5 and 7 to different coordinates. The superior damping capacity of the plastic, which may more than compensate for its low fatigue strength, is thus a desirable feature in aircraft and other members subjected to vibration-inducing forces. However, the duralumin member may be more durable than the plastic member, if static loads are superimposed or if nonresonant vibrations are excited, or if other damping agents are present in the vibrating system.

The cold-working accompanying sustained cyclic stress may greatly affect the damping capacity of a material. The vibration-decay method (12) and the static method (19) of determining damping capacity cannot readily reveal the effects of the cold-working since these methods subject the specimen to only a few cycles of stress and thus yield only the properties of the more or less virgin material. However, in the resonant-vibration method, used in the present work, any number of stress cycles can be applied and the cold-working may cause an increase in the resonance-amplification factor.

Damping capacity of materials as reported by different observers differ widely, depending upon the method of observation (8). An important reason for the experimental scatter is explained as follows. The observed damping capacity of a material obtained by any dynamic method depends upon the vibrational-energy losses in the entire system. These losses are due to hysteresis within the specimen and to extraneous

7—*Comparison of resonant-vibration stresses in plastic and duralumin.* **8**—*Resonance-amplification factor and modulus of elasticity of plastics under longitudinal vibrations*

7



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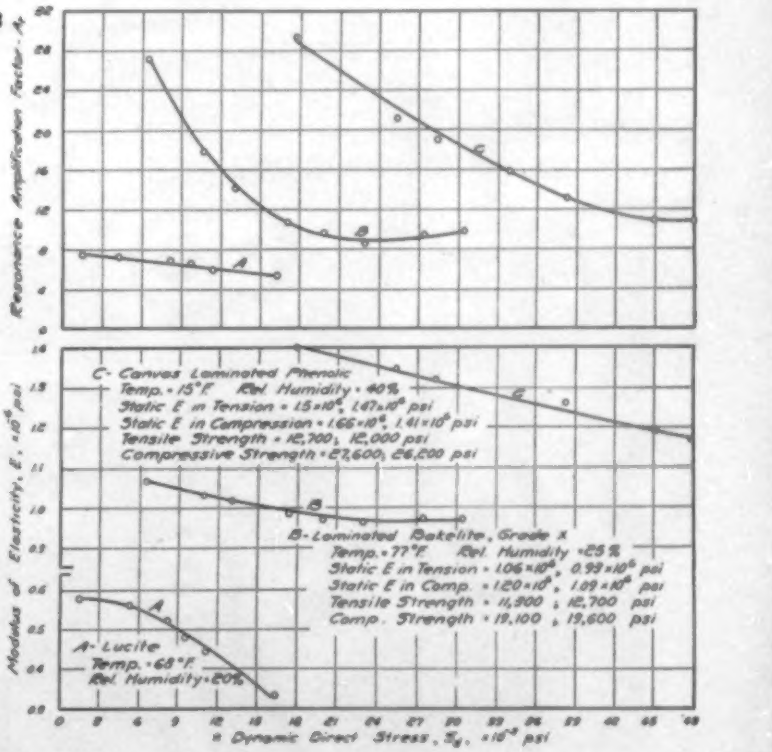
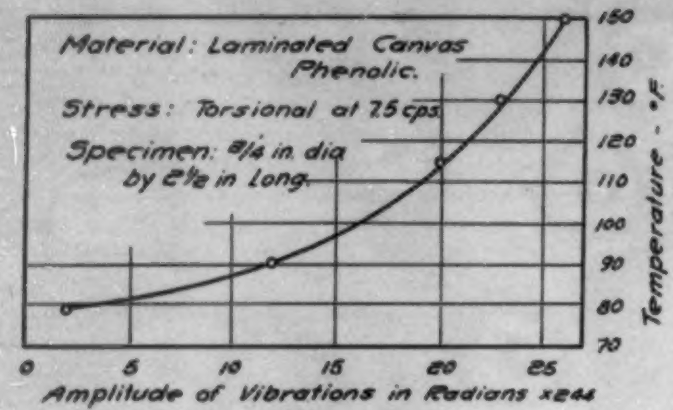




9—A Typical temperature-increase curve for a plastic under cyclic stress

work done at the supports and loose parts, slippage between specimen and chucks, and general vibration radiation. If these extraneous losses are not small in comparison with the hysteresis energy absorbed, which in itself is rather small for metals, then the values observed for the damping capacity of the material will be too large.

Numerous precautions were taken in this study to minimize the extraneous energy losses and other sources of error. While there is no simple method of evaluating the effectiveness of these precautions, the data agree with other test values of damping capacity (tests on magnesium alloys, not reported herein, reasonably check reference 12, and the data for the laminated phenolic plastics agree well with reference 15). Since damping capacity is highly structure-sensitive, a close comparison is not to be expected.

Dynamic moduli of elasticy. The dynamic moduli of elasticity of a material, or the ratio of stress to strain effective during a vibration, is usually lower than the static moduli. The four main reasons for this deviation are temperature increases caused by damping, hysteresis-loop distortions, cold-working and thermodynamic effects, which will be discussed in that order.

1. Materials often become very warm under cyclic stress because their damping capacity dissipates part of the vibrational energy as heat. Since the mechanical properties of materials are a function of specimen temperature, the dynamic modulus of elasticity deviates from the static value. Most metals possess comparatively low damping capacity, and furthermore their moduli are rather insensitive to temperature changes. The temperature of iron and steel, for example, may be increased about 100° above room temperature before a 1 percent change in the modulus results (14). Thus the dynamic moduli of elasticity of metals should not be greatly influenced by the temperature effect. Plastics and many other nonmetallic materials, on the other hand, possess high damping capacity and therefore heat up considerably under cyclic stress (16). Figure 9 shows the equilibrium temperature of the specimen as a function of dynamic stress for a phenolic-laminated plastic. Furthermore, the mechanical properties of nonmetals are highly sensitive to temperature change (17). For example, the modulus of elasticity in tension of the average phenolic plastic decreases about 30 percent as the temperature is increased from −38 to 78° F. (13). The dynamic moduli of elasticity of plastics should, therefore, be lower than the static modulus, especially at high stress. Most of the decrease in the dynamic moduli for the plastics shown in Figs. 6 and 7 is probably due to the temperature effect.

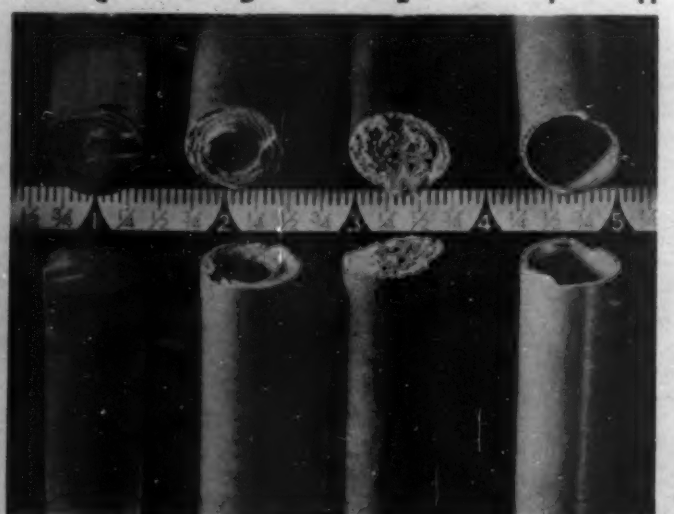
2. A material exhibiting a curved stress-strain diagram or a measurable hysteresis loop in a given stress range does not have a constant static modulus of elasticity. The variation in the static modulus during a cycle of stress depends upon the area of the hysteresis loop, or damping capacity, and therefore increases with magnitude of stress. The dynamic modulus of elasticity for a given stress cycle is some average of the variable static modulus over this cycle. Therefore, materials possessing high damping capacity should have a lower dynamic than static modulus of elasticity (measured on the upward branch of the load-deflection curve) and also show a decrease in the dynamic modulus as the stress increases. The small reduction in the moduli of the metals as the stress increases, and part of the large drop observed in the plastics, are probably associated with the hysteresis-loop effect.

(*Please turn to page 136*)

10—Torsional-vibration fatigue failures (A—steel tubing; B—nickel tubing; C—paper phenolic tubing; D—polymethyl methacrylate rod). 11—Longitudinal-vibration fatigue failures (C—paper phenolic tubing; D—polymethyl methacrylate rod; E—canvas phenolic rod; F—aluminum tubing)

A B C D 10

C D E F 11



Plasticizers

by JOHN M. DeBELL*

PLASTICIZERS are non-volatile materials, usually liquid, which are added to high molecular weight plastics to make them tougher or to soften them at room or working temperatures. Popularly, they are visualized as attaching themselves by virtue of the attraction between certain of their chemical groups and specific groups on the large base molecule so that they hold the large molecules apart and permit them to slide over each other more freely. As one English writer has put it, "The function of a plasticizer is to fill voids in the molecule space lattice, to form planes of easy glide."[1]

The action of camphor on cellulose nitrate was one of the most striking early examples in this art and camphor remains to this day one of the best plasticizers for 11 percent nitrocotton. Other examples of the softening action are seen in the cellulose acetate plastics where 20 percent to 35 percent plasticizer is necessary to give toughness and to permit formation of good structures at injection molding temperatures sufficiently low to prevent decomposition of the cellulose derivative; in the admixtures with vinyl resins which give physical characteristics similar to flexible vulcanized rubber; and in the rubbers themselves, especially with the acrylic nitrile-butadiene types in which it is difficult to break down the plastic. In addition to the softening action, plasticizers may impart special characteristics: phosphates give good fire resistance, saturated hydrocarbons maintain high dielectric properties, and waxes improve water resistance. Broadly speaking, when they are good solvents for the film former with which they are used, they confer toughness and rather poor cold flow characteristics. When they are nearer the point of insolubility, they give high tensile strength, greater rigidity and less shock strength. The former types are called solvent plasticizers and the latter extender plasticizers.

By proper formulation, good solvent plasticizers will bring into solution materials which, by themselves, are not even sufficiently soluble to form one phase with the plastic. It is apparent, therefore, that plastics can be formulated by combinations of plasticizers to adjust workability and mechanical characteristics. However, good toughness characteristics cannot be conferred on a plastic unless the film former has good intrinsic characteristics of its own, notably sufficient molecular length and absence of too much *side loading* on the molecule, as, for example, the rings in polystyrene and long fatty acids like stearates on cellulose esters.

Properties

Besides a certain amount of solvent power for the plastic base, the plasticizer should be of very low volatility, good heat stability, unaffected by water and lightfast. For food uses, low odor and non-toxicity are desirable. An excellent summary of test methods and behavior of various plasticizers with cellulose derivatives has been published by Fordyce and Meyer;[2] and Gloor and Gilbert.[3] Vulcanizable plasticizers which can be treated by methods similar to rubber curing, to confer non-melting characteristics on plastics, have been described by Garvey and others.[4]

Chemically, many of the plasticizers are high boiling esters. While a host of such materials have been proposed, the bulk of commercial work is done by a comparatively small number which have won their position by excellent technical performance and by low cost.

Standard combinations

Some of the standard plasticizer combinations for industrial use are as follows:

Cellulose acetate: dimethyl and diethyl phthalates; triphenyl phosphate for reducing flammability and sharpening the softening point; sulfamids except where light stability is required; methyl phthalyl ethyl glycolate and methoxyethyl phthalate.

Cellulose triacetate: cyclohexonyl stearate and higher phthalates.

Cellulose acetate butyrate: phthalates and tripropionin.

Cellulose nitrate, 11 percent nitrogen for plastics: camphor, tricresyl phosphate.

Cellulose nitrate, 12 percent nitrogen for lacquer: dibutyl phthalate.

Cellulose nitrate, 12 percent for artificial leather: castor oil.

Vinyl chloride: higher phthalates such as octyl, capryl or butoxyethyl; tricresyl phosphates for flame proofing, low temperature flexibility and low loss on heating.

Rubber: paraffin, pitches, pine tar, cumar, dibutyl phthalate, dibutyl sebacate.

Vinyl chloride acetate: dioctyl phthalate, tricresyl phosphate for flame proofing and esters of high acids.

Vinyl butyral for safety glass: dibutyl sebacate, triethylene glycol dihexoate and similar poly glycol esters.

Vinyl acetate: simple phthalates, ether phthalates.

Ethyl cellulose: phthalates, chlor diphenyl; castor and other vegetable oils for rubbery characteristics.

Regenerated cellulose: glycerine or glycols; protein materials, acyl glucosides.

Chlorinated rubber: diamyl and higher phthalates.

Integral plasticization

In addition to these types of plasticizers which are completely described in the accompanying tables and which are introduced by mechanical admixture, mention should be made of the possibility of obtaining similar plasticizing action by chemically combining proper groups directly on the molecule itself. Thus in vinyl chloride acetate, the acetate group serves to act as a plasticizer even though additional plasticizers may be required. In the alkyd resins, the monobasic fatty acids perform a similar function. In cellulose acetate butyrate, the butyric acid helps to soften the plastic and to require only small amounts of additional admixed plasticizers. The phenyl groups on styrol play a similar part in butadiene styrene synthetic rubber. Methacrylate injection plastics derive their plastic properties preferably by copolymerization of small amounts of (*Please turn to page 128*)

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* Plastics Consultant.

[1] Clark, F. W., Chemistry and Industry, *60*, 225-8 (1941).

[2] Fordyce, C. R., and Meyer, L. W. A., Ind. Eng. Chem., *32*, 1053 (1940).

[3] Gloor, W. E., and Gilbert, C. B., Ind. Eng. Chem., *33*, 597 (1941). Note: Good Bibliography.

[4] Garvey, B. S., Jr., Alexander, C. H., Küng, F. E., and Henderson, D. E., Ind. Eng. Chem. *33*, 1060 (1941).

The economics of automatic molding

by R. C. GLASIER

THIS study was undertaken to examine the economics of molding plastics in automatic presses in comparison with semi-automatic presses manually operated. The problem comes down to one of finding the proper number of mold cavities for the minimum cost under the two conditions. The number of cavities in a mold may in many cases be dictated by output schedules, but in this discussion the lowest possible cost is to be the only consideration. For this purpose, a formula was developed taking into account the principal cost elements, such as the mold, press and labor. Material cost and finishing operations are expected to be the same in both cases. Parts requiring inserts are excluded from consideration, although it has sometimes been found more economical to resort to automatic molding and apply the inserts to the finished piece.

Derivation of cost-per-part formula, semi-automatic press

Mold cost. The cost of the mold will increase in direct ratio to the number of cavities, except that in multi-cavity molds the cost per cavity is less for additional cavities than for the first cavity. Therefore, from MX, where M is the cost per part of the first cavity and X is the number of cavities, we must subtract an amount, a, which represents the decrease in cost per cavity per part for each additional cavity beyond the first. The number of parts represents the total demand. The formula then becomes

$$MX - a(X - 1)$$

It was assumed in calculating mold costs that a six-cavity mold could be made 20 percent cheaper per cavity than a single-cavity mold, and that the cost would be the same whether used for an automatic or semi-automatic press.

Press cost. Inasmuch as the cost of a molding press will increase with the tonnage required for additional cavities, a factor, d, must be added to the cost of the press time for one cavity, P, to take this into account. Therefore, the press cost becomes

$$P + d(X - 1)$$

In a semi-automatic press, the loading and unloading time will increase with the number of cavities and, consequently, a factor b is needed to account for the increased time the press is in use. This factor is assumed to increase in direct proportion to the number of cavities and the formula then becomes

$$P + d(X - 1) + [P + d(X - 1)]\, b\, (X - 1)$$

where b is a percentage of the time required for one cavity.

Inasmuch as we are interested in the cost per part, this total cost must be divided by the number of cavities to account for the number of parts produced per cycle.

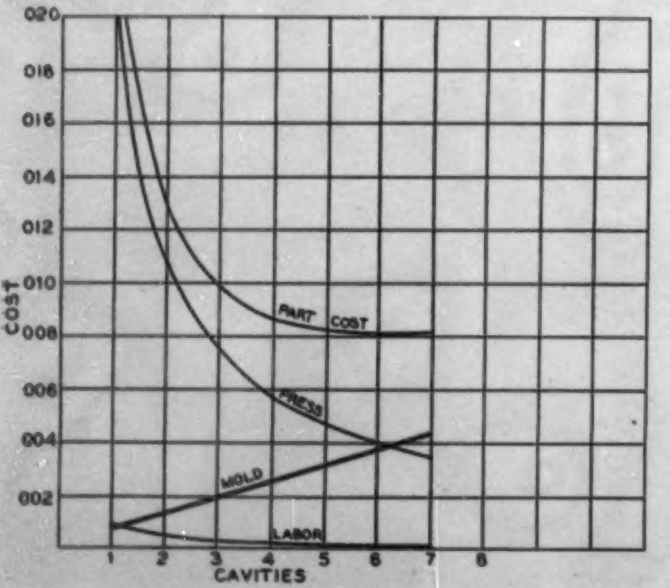
$$\frac{P + d(X - 1) + [(P + d(X - 1)]\, b\, (X - 1)}{X}$$

It is necessary in order properly to establish the economics of automatic molding to take into account the greater cost of automatic molding presses. This has been found to be about \$1000, regardless of tonnage, in the range for which figures on automatic presses are available. The press cost per ton for the additional tonnage to operate beyond one cavity, also needed to apply the formula, has been found to be \$80 for either automatic or semi-automatic presses. Only self-contained presses were considered. This matter of press cost is somewhat theoretical, as presses are not graduated in tonnage and size to agree exactly with that required for the optimum number of mold cavities.

Carrying charges to cover depreciation, interest on investment, repairs and taxes are figured at 25 percent of the press cost. Overhead has been applied to press operating hours as the best method of distribution for making a comparison of the two types of press. The carrying charges on the press are omitted from the loading rate, as this element of cost is taken directly into account in the formula.

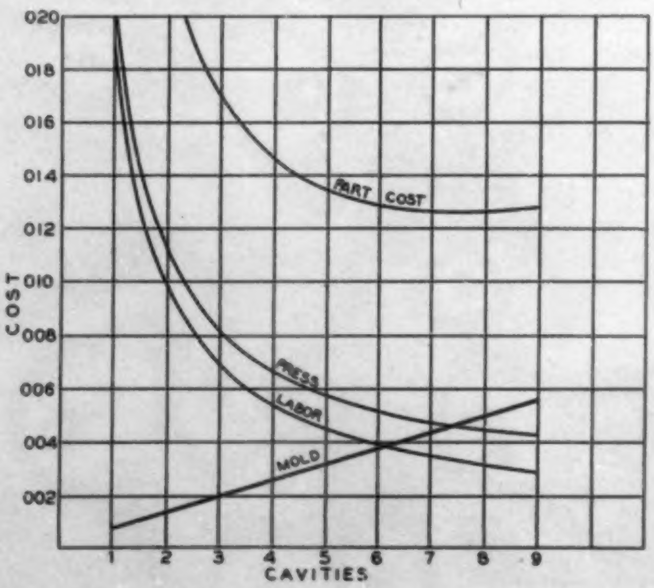
1—Cost curves for part A when made on a semi-automatic press.

1



2—Cost curves for part A made on an automatic press

2



The cost of setting up the molds is included in the loading and is assumed to be the same for either semi-automatic or automatic presses, although some molders may feel that automatic presses require more attention in this respect.

Labor cost. The labor cost, L, for one cycle operation with one cavity must also be corrected for the additional time consumed in loading and unloading the additional cavities, the curing time being assumed to be constant. Inasmuch as this is the same as the additional press time, the same factor b may be used. The labor factor L may, however, represent only $1/2$, $1/3$, $1/4$, etc., of the cost of labor for the cycle time of a one-cavity mold when the relation of the "open" to "closed" time is such that one operator may attend two or more presses. The labor cost per part then becomes

$$\frac{L + Lb(X - 1)}{X}$$

Cost per part. The total cost of the part y molded in a semi-automatic press then becomes

$$y = MX - a(X - 1) + \frac{P + d(X - 1) + [P + d(X - 1)]b(X - 1)}{X} + \frac{L + Lb(X - 1)}{X}$$

$$= MX - aX + a + \frac{P + dX - d + (P + dX - d)(bX - b)}{X} + \frac{L + LbX - Lb}{X}$$

$$= MX - aX + a + \frac{P + dX - d + PbX + bdX^2 - 2bdX - Pb + bd}{X} + \frac{L + LbX - Lb}{X}$$

$$= MX - aX + a + \frac{P}{X} + d - \frac{d}{X} + Pb + bdX - 2bd - \frac{Pb}{X} + \frac{bd}{X} + \frac{L}{X} + Lb - \frac{Lb}{X}$$

Taking the first derivative and setting it equal to zero to find the value of X for the minimum cost:

$$\frac{dy}{dx} = M - a - \frac{P}{X^2} + \frac{d}{X^2} + bd + \frac{Pb}{X^2} - \frac{bd}{X^2} - \frac{L}{X^2} + \frac{Lb}{X^2}$$

$$X^2 = -\frac{-P + d + Pb - bd - L + Lb}{M - a + bd}$$

Derivation of cost-per-part formula for an automatic press

The same cost factors apply in arriving at the most economical number of cavities for a mold used in an automatic press, except that in this case the cycle time is assumed to be constant regardless of the number of cavities. This is consistent with the usual practice on automatic molding presses which provide for the ejection of the parts from all cavities simultaneously, as well as the blowing out of the mold and refilling with powder.

The per cavity cost of the mold will be reduced as the number of cavities increases and the same formula applies

$$M - a(X - 1)$$

The press cost will increase with the tonnage for the greater number of cavities, but due to the uniform cycle the factor to

TABLE I.—COST CALCULATIONS FOR SEMI-AUTOMATIC MOLDING OF PLASTIC PARTS

	Part A	*Part B*	*Part C*
Quantity to be produced	500,000	120,000	40,000
Cycle time	2.04 min.	4.4 min.	3.22 min.
Cure time	63 sec.	210 sec.	140 sec.
Time for each additional cavity	6 sec.	6 sec.	6 sec.
Mold cost, single cavity	$400	$550	$350
Mold cost, multi-cavity	20% less per cavity for 6 cavities		
M (cost of mold per part for 1st cavity)	.00080	.00458	.00875
a (decrease in mold cost per part per cavity for each additional cavity)	.00019	.00110	.00210
Tons pressure per cavity	4	2	2
Press cost			
For single cavity	$1320	$1160	$1160
For each additional cavity	$320	$160	$160
Operating hours per year	3120	3120	3120
Hourly press cost, loaded			
For single cavity mold	.60580	.5931	.5931
For each additional cavity	.02560	.0128	.0128
P (press charge per cycle for 1st cavity)	.02060	.04350	.0318
d (increase in press charge per cycle for each additional cavity)	.00087	.00094	.00069
b (increased cycle time for each additional cavity)	4.9%	2.3%	3.1%
Labor cost per cycle	.01870	.04030	.0295
Presses per operator	1	4	3
L (labor cost per cycle per press)	.01870	.01007	.00983
Solving for X_m (no. of cavities giving minimum cost)	7.5	3.8	2.4
Substituting the following values for X and solving for Y:			
X (no. of cavities)	7	4	2
Y (total cost per part)	.01268	.03008	.03720

Table II.—Cost Calculations for Automatic Molding of Plastic Parts

	Part A	*Part B*	*Part C*
Quantity to be produced	500,000	120,000	40,000
Cycle time	2 min.	4 min.	3 min.
Mold cost, single cavity	$400	$550	$350
Mold cost, multi-cavity		20% less per cavity for 6 cavities	
M (cost of mold per part for 1st cavity)	.00080	.00458	.00875
a (decrease in mold cost per part per cavity for each additional cavity)	.00019	.00110	.00210
Tons, pressure per cavity	4	2	2
Press cost			
For single cavity mold	$2320	$2160	$2160
For each additional cavity	$320	$160	$160
Operating hours per year	4576	4576	4576
Hourly press cost, loaded			
For single cavity mold	.62680	.61810	.61810
For each additional cavity	.01750	.00875	.00875
P (press charge per cycle for 1st cavity)	.02180	.04140	.03086
d (increase in press charge per cycle for each additional cavity)	.00058	.00058	.00046
Labor cost per cycle	.01830	.03660	.02750
Presses per operator	20	20	20
L (labor cost per cycle per press)	.00091	.00183	.00137
Solving for X_m (no. of cavities giving minimum cost)	6.05	3.48	2.2
Substituting the following values for X and solving for Y:			
X (no. of cavities)	6	4	2
Y (total cost per part)	.00811	.02625	.03174

cover the increased loading and unloading time may be dropped. Thus we have only:

$$\frac{P + d(X - 1)}{X}$$

Similarly, the labor cost will remain uniform due to the constant cycle time, but L represents the labor cost for only that fraction of the time of an operator, who is attending a number of presses, devoted to any one press, or simply:

$$\frac{L}{X}$$

Experience indicates that one operator can attend as many as twenty automatic presses and the calculations have been made on this basis.

The part cost then becomes:

$$y = MX - a(X - 1) + \frac{P + d(X - 1)}{X} + \frac{L}{X}$$

$$= MX - aX + a + \frac{P + dX - d}{X} + \frac{L}{X}$$

and the first derivative:

$$\frac{dy}{dx} = M - a - \frac{P}{X^2} + \frac{d}{X^2} - \frac{L}{X^2}$$

$$X^2 = -\frac{-P + d - L}{M - a}$$

Computed costs for typical parts

Calculations in accordance with these formulas have been worked out for three parts designated A, B and C and the results are shown in Tables I and II. Curves showing the relation of the cost elements for semi-automatic and automatic molding of part A are shown in Figs. 1 and 2, respectively. The quantities to be produced, cycle times, etc., are taken from actual examples encountered in a molding shop.

The value of M is the mold cost divided by the number to be produced, which for part A becomes:

$$M = \frac{400}{500{,}000} = .00080$$

The factor a represents the 20 percent reduction in cost per part of a six-cavity mold over a single-cavity mold or:

$$6 \times 400 = 2400$$
$$2400 \times .20 = 480$$
$$\frac{480}{500{,}000 \times 5} = .00019$$

The factor 5 in the denominator distributes the reduction over the last 5 cavities, as the first cavity costs the full amount.

The press cost of $1320 for a four-ton press for the single-cavity mold is the theoretical cost of a four-ton semi-automatic press taken from a graph representing the mean cost of a large number of presses of various tonnages. The $320 increment for each additional cavity is found by multiplying the four tons required for each cavity by the $80 increased press cost per ton taken from the same graph.

The hourly press cost works out as follows:

$$\frac{\$1320 \times 25 \text{ percent (carrying charge)}}{3120 \text{ (operating hours)}} + .50 \text{ (hourly loading rate)} = .60580$$

and the press cost for each additional cavity becomes:

$$\frac{320 \times .25}{3120} = .02560$$

P then equals the:

$$\frac{\text{Cycle time}}{60 \text{ min.}} \times \text{hourly press cost}$$

$$\frac{2.04}{60} \times .60580 = .02060$$

(*Please turn to page 120*)

Technical briefs

Abstracts of articles on plastics in the world's scientific and engineering literature relating to properties and testing methods, or indicating significant trends and developments

Engineering

CHOICE OF PLASTIC MATERIALS AS AFFECTED BY FABRICATION. H. C. Hillman. Product Eng. *13*, 584–7 (Oct. 1942). In selecting a plastic material best suited to the desired design of a given part there are three general considerations in addition to the physical and chemical characteristics of the materials, which have an important bearing upon the choice. These are the physical forms of the raw materials that are commercially available, the comparative advantages of the various methods of producing either a finished or unfinished part from these raw materials and the fabricating operations which may be necessary on an unfinished part of the solid raw materials. It is recommended that plastics be considered for making the following aircraft parts: blisters, bushings, cable guards, cable stops, canopies, conduit, doors (baggage, bomb, cabin, emergency exit, inspection, landing gear), ducts, fairings, fairleads, fittings (armament, control, equipment, hydraulic, tubing), flooring, furnishings, fuse boxes, handles, idler horns, instrument panels, interior furnishings, junction boxes, knobs, propeller spinners, reflectors, scoops, shell chutes, silent gears, surface tabs, tab drums, tail cones, tanks, terminal blocks, wing leading edges and wing tips.

SHORT WAVE INDUCTION HEATING. Elec. West *89*, 46–7 (Aug. 1942). A description of a plywood plant which utilizes short-wave induction heating. The plant is equipped with two presses which have electrodes 8 ft. by 4 ft. and 10 ft. by 4 ft., respectively. The heating is accomplished with 600 kw. operating at 2,000,000 cycles per second.

Chemistry

THE STRUCTURE OF COPOLYMERS OF VINYL CHLORIDE AND VINYL ACETATE. C. S. Marvel, G. D. Jones, T. W. Mastin and G. L. Schertz. J. Am. Chem. Soc. *64*, 2356–62 (Oct. 1942). Vinyl chloride and vinyl acetate copolymerize to produce polymer chains containing both units. However, the polymer molecules produced in a given case differ widely in composition and the first chains produced are richer in vinyl chloride than is the monomer mixture from which they are formed. The copolymers made by complete polymerization of a given starting mixture of monomer vary in composition from chain to chain. The monomer units appear to be oriented in a 1,3-fashion in the polymer chain. The results of dehalogenation, hydrolysis and solubility experiments made on these copolymers are described.

THE FORMATION OF ALDEHYDE GROUPS DURING THE HARDENING OF PHENOL DIALCOHOLS—STUDIES ON PHENOL-FORMALDEHYDE RESINS. K. Hultzsch and G. Schiemann. Berichte *75*, 363 (Apr. 1942). Three phenol dialcohols, *p*-tert-butylphenol dimethylol, *p*-diisobutylphenol dimethylol, and *p*-cresol dimethylol were polymerized by heating and the products analyzed. The number of aldehyde groups were determined by analyzing the oxime derivatives of the resins for nitrogen content. It is concluded that 1) two aldehydes are present in each molecule of resin and 2) the percentage of aldehyde groups in resins made from *p*-cresol dimethylol increases with the curing temperature up to 110° C. and then remains constant.

ACTIVE FILLERS IN MICRO- AND MACROMOLECULAR LIQUIDS. Kurt Ueberreiter. Angew. Chem. *54*, 508–12 (1941). The effect of carbon black filler on the properties of rubber-like high polymers is explained on the basis that carbon black is effective only in a temperature range in which the cohesive power of the liquid molecule becomes equal to the elastic binding power of the active surface. This temperature range is always higher than the congealing temperature. Rubber-like polymers congeal at temperatures well below those at which they are used. Conversely, such a filler would not be wetted, and therefore not effective, in alkyd resins, phenol-formaldehyde resin, polystyrene, polyvinyl chloride, acrylic resins and cellulose derivatives.

Testing

ISOLATION AND IDENTIFICATION OF THE RESINOUS BINDER IN WATER PAINTS. R. W. Stafford. Ind. Eng. Chem. Anal. Ed. *14*, 694–99 (Sept. 1942). An analytical procedure for the isolation and identification of the resinous binders used in water-emulsion paints is outlined and discussed. The resinous binder may be isolated by 1) benzene distillation, 2) cold separation with alcohol and benzene or 3) cold separation with acetone, benzene and petroleum ether. The separated resins are identified by 1) a qualitative physical examination covering such properties as odor on ignition, hardness, homogeneity, color, etc., 2) determination of physical and chemical constants such as softening range, refractive index, density, and acid and saponification values, 3) elementary analysis, 4) solubility in various solvents, 5) classification tests such as those reactions with certain chemicals which give colored products. In addition to these general methods, analytical methods are given for the identification of modified alkyd resins and rosin esters or rosin adducts. A procedure is given for the separation of an alkyd resin into the acids, alcohols and modifiers used to synthesize it. A method for the identification of rosin adducts by ultraviolet spectroscopy is outlined.

VINYL ELASTOMERS. LOW-TEMPERATURE FLEXIBILITY BEHAVIOR. R. F. Clash, Jr., and R. M. Berg. Ind. Eng. Chem. *34*, 1218–22 (Oct. 1942). A torsional apparatus has been developed and applied to the measurement of the low-temperature flexibility of elastomers of vinyl copolymer resins. This measurement determines a composition's "flex" temperature, which is defined as the lower temperature limit of the compound's usefulness as an elastomer. Data for compositions of vinyl copolymers with single plasticizers are given. It is established that the flex temperature behavior of binary and ternary systems can be predicted on a simple additive basis.

Properties

THE EFFECT OF TEMPERATURE AND SOLVENT TYPE ON THE INTRINSIC VISCOSITY OF HIGH POLYMER SOLUTIONS. T. Alfrey, A. Bartovics and H. Mark. J. Am. Chem. Soc. *64*, 1557–60 (July 1942). The specific viscosity of a dilute solution of polystyrene or rubber is strongly dependent upon the nature of the solvent; the specific viscosity is high in a good solvent, and low in a poor solvent or a solvent-nonsolvent mixture. This has been interpreted as being due to changes in mean molecular shape. The specific viscosities of cellulose acetate solutions are not so sensitive to the nature of the solvent. The extrapolated specific viscosity at the limit of solubility is in the same range for several different solvent-nonsolvent systems. The effect of a temperature increase is to lower the specific viscosity of rubber or polystyrene solutions in a good solvent, but to increase the viscosity in a mixture of a solvent and nonsolvent. The specific viscosity of a dilute polystyrene solution is more nearly linear with concentration in a toluene-methanol mixture than in pure methanol. The quadratic term b in the equation, $\eta_{sp} = ac + bc^2$, where η_{sp} = specific viscosity and c = concentration, is reduced.

Plastics digest

This digest includes each month the more important articles of interest to those who make or use plastics. Mail request for periodicals mentioned directly to individual publishers

General

THE USE OF PLASTICS IN BUILDING. R. J. Schaffer. Chemistry and Insustry (London) *61*, 357–61 (Aug. 22, 1942). Plastics are discussed and compared with common building materials both as to physical properties and costs. Molded fittings, laminated plastics, plywood, resin-impregnated wood, plastic window frames and doors and plastics as load-bearing materials are discussed. It is concluded that: 1) plastics have already an established reputation for use as decorative wall coverings, as fittings and for sundry other building purposes; 2) improvements will need to be effected in certain of their physical properties if plactics are to be used in competition with wood and steel as load-bearing parts of buildings; 3) full-scale tests will be required; 4) synthetic resin-bonded plywood has demonstrated its utility for outdoor use; 5) although laminated and some types of molded plastics can be used with limitations out of doors, it is not justifiable to suppose that the use for this purpose of the products so far available will eliminate the need for maintenance decoration. Further information on the effects of weathering is needed before plastics can be recommended for use externally in home construction.

AVIATION PLASTICS POSSIBILITIES. E. F. Lougee. Western Flying *22*, 32–3, 82, 84, 86 (Sept. 1942). Developments in the adaptation of plastics to the aircraft industry are described. Starting with the Clark Aircraft Corp. in 1938, the aviation industry has found it possible to use plastics and plastic-plywood for many of its needs. These applications and the plastic materials employed in them are reviewed. The need for closer cooperation between plastics and aircraft interests is stressed and those agencies which are undertaking to correlate such activities are discussed.

ADHESION AND ADHESIVES, WITH SPECIAL REFERENCE TO ANTI-SCATTER TREATMENTS FOR WINDOWS. PART I. ADHESION AND ADHESIVES. B. Butterworth. Chemistry and Industry (London) *61*, 339–41 (Aug. 8, 1942). A brief discussion of the theories concerning adhesion and of the properties of the various commercial types of adhesives. It is stated that "fabric-varnish treatments have in fact been used successfully for the protection of windows, notably those of transport vehicles." PART II. PROPERTIES REQUIRED IN ADHESIVES FOR WINDOW PROTECTION. Chemistry and Industry *61*, 350–1 (Aug. 15, 1942). An adhesive should have the following properties to hold textile fabrics and transparent films to window glass: 1) it should hold the protective material to the glass with sufficient strength initially to be effective; 2) it should have no effect on the strength of the fabric or film; 3) it should not injure the glass; 4) it should not become brittle or flake away from the glass on exposure; 5) its adhesiveness should not be unduly weakened by exposure to very humid air; 6) it should not encourage the growth of molds. It is concluded that where windows may be subjected to condensation of moisture, good non-aqueous varnishes and lacquers are the best adhesives for fabrics. Where condensation and high humidity are unlikely, cold water pastes may be used with fabrics. Gum arabic and glycerine mixtures are recommended for use with cellulose films, but where resistance to moisture is required, it is necessary to varnish over the film. No suitable adhesive was found for cellulose acetate film.

Materials

FRACTIONATION OF CELLULOSE ACETATE. A. M. Sookne, H. A. Rutherford, H. Mark and M. Harris. J. Res. Nat. Bur. Standards *29*, 129–30 (Aug. 1942). Also Amer. Dyestuff Rep. *31*, 417–20 (Aug. 31, 1942). A sample of commercial cellulose acetate in acetone solution was separated into 15 fractions by using ethyl alcohol as a precipitant. The initial material had a viscosity of 93 sec. in 4:1 acetone solution and an acetyl content of 38.6 percent. The degree of polymerization (determined from specific viscosity), acetyl content, ash content and melting point of the various fractions are reported. A large proportion of the ash and haze-producing materials of the entire starting material is removed in the first fraction.

THE POLYMERIZATION OF STYRENE CATALYZED BY *p*-BROMOBENZENEDIAZONIUM HYDROXIDE. C. C. Price and D. A. Durham. J. Am. Chem. Soc. *64*, 2508–9 (Oct. 1942). *p*-Bromobenzenediazonium hydroxide has been found to catalyze the polymerization of styrene. The polymer form contained an average of about 22 styrene units. Since no polystyrene was formed in a parallel experiment in which the diazonium salt was omitted, it appears that the *p*-bromophenyl radicals from the decomposition of *p*-bromobenzenediazonium hydroxide are capable of initiating the polymerization of styrene and are thereby incorporated in the polymer.

INFORMATION ON THE CURING OF PHENOL-FORMALDEHYDE RESINS. A Zinke, M. Tomio and K. Lercher. Berichte *75*, 151–5 (Feb. 1942). Samples of *p*-cyclohexylphenol dimethylol were cured by three techniques at various temperatures and the loss in weight determined. The resins were dissolved in benzene, treated with hydrogen bromide and the bromine content of the product determined. It is concluded that: 1) at lower temperatures the predominant product during cure is water; 2) at higher temperatures the predominant product is formaldehyde; 3) above 190° C. an oily product is obtained, chiefly *p*-cyclohexylphenol-*o,o*-dialdehyde; 4) at curing temperatures below 170° C. polyethers predominate in the cured resin; and 5) above 170° C. the number of hydrolyzable ether bridges is greatly reduced. Four hypotheses to explain the decrease in ether linkages are advanced.

INDUSTRIAL PROTEIN CHEMISTRY 1941–1942. J. Bjorksten. Chemical Industries *51*, 366–70 (Sept. 1942). A review of the patent literature concerning casein for 1941–1942. The uses of casein in adhesives, coatings, paints and plastics are included among others. One patent of interest to the plastics industry covers a mixture of polyamides of the nylon type with proteins which is claimed to have higher mechanical strength than either component alone.

Applications

CLOSURES AND THE BOTTLENECK. Modern Packaging *16*, 37–52 (Sept. 1942). Steel used for closures on glass containers in 1941 amounted to 225,000 tons. A critical situation is involved in the replacement of this steel by other materials in order to make it available for building ships. During 1941 the glass container industry used about 15,000,000 pounds of plastics for closures, of which approximately 70 percent was phenolics and 30 percent urea resins. To replace metal closures, exclusive of those used for process foods and home canning which require metal, 50,000,000 pounds of plastic molding powders would be needed. Phenol-formaldehyde resins are not available for this purpose because of high priority applications for this type of plastic. Urea-formaldehyde resins are in good supply, but production would have to be expanded materially to meet the full requirements of the packaging trade

Bell Telephone Laboratories Use This 12 oz. *H-P-M PLASTIC INJECTION MOLDING PRESS* To Obtain Actual Production Data For Their New Thermoplastic Telephone Parts ★

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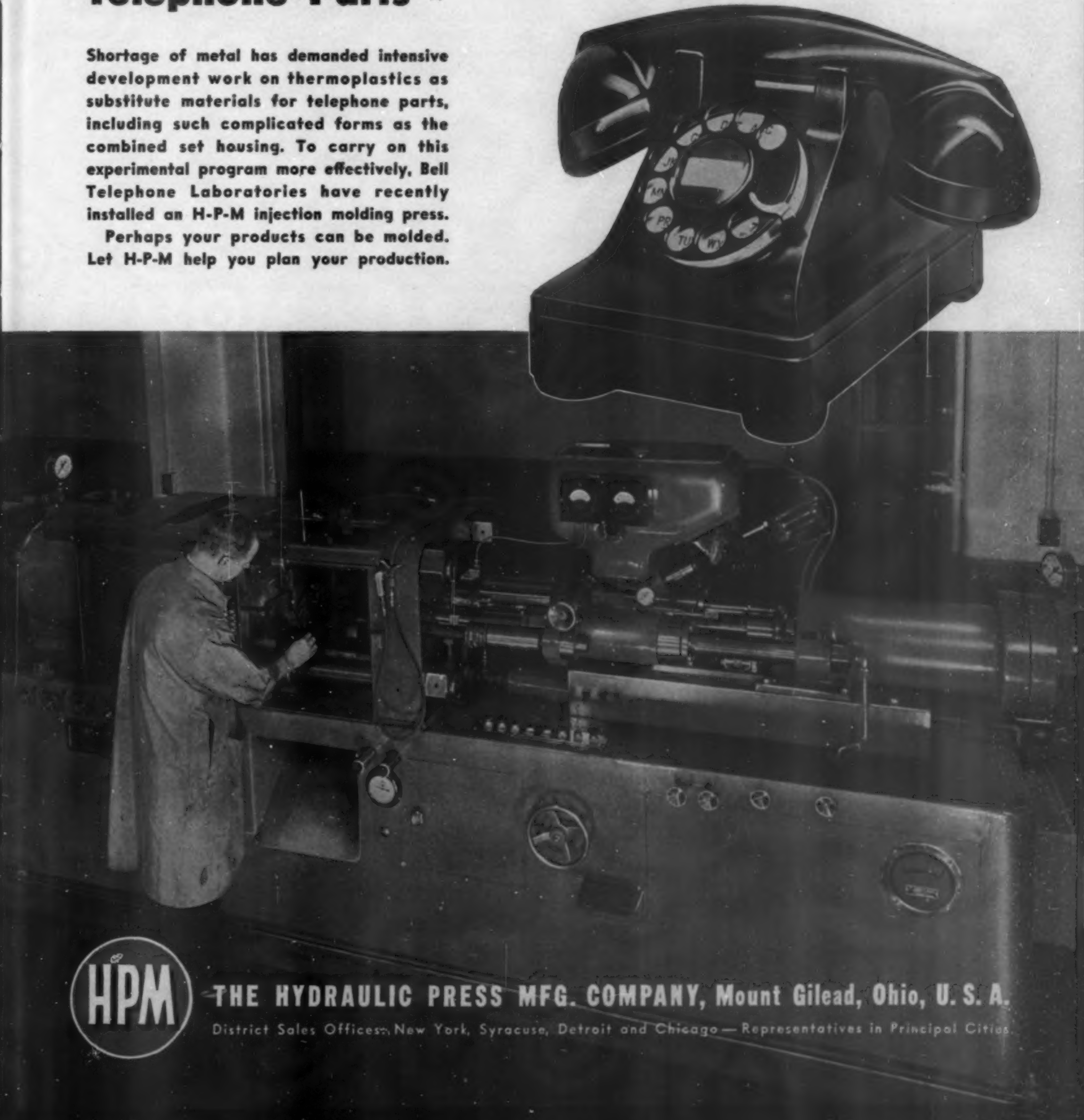

Ewing Galloway

U. S. Plastics Patents

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 10 cents each

DYEING FOILS. J. H. Rooney, P. R. Hawtin and S. R. Chaplin (to Celanese Corp. of America). U. S. 2,293,174, Aug. 18. Apparatus for coloring films or foils during the film-casting operation.

THERMOPLASTIC WEBS. W. M. Stocker (to Cameron Machine Co.). U. S. 2,293,178, Aug. 18. Cutting strips from a running heated thermoplastic web with a hot cutter which seals the cut edge.

VULCANIZED FIBER BACKING. Horace B. Fay. U. S. 2,293,246, Aug. 18. Backing belts for abrasives are made of vulcanized fiber reinforced with glass fiber.

FLUORINE CONTAINERS. J. A. M. W. Mitchell (to Imperial Chemical Industries, Ltd.). U. S. 2,293,266, Aug. 18. Synthetic rubber, made by polymerizing diolefins in presence of hydrofluoric acid or a polyfluoride, is used to line fluorine containers.

COLORFAST RESIN. W. H. Carmody (to Neville Co.). U. S. 2,293,277, Aug. 18. Discoloration of resinous cyclopentadiene polymers by fulvene formation is prevented by catalytic hydrogenation of the fulvene-forming component without degradation of the resin.

SQUEEZING LIQUID FROM PLASTICS. S. Kiesskalt, K. Winnacker and K. Erb (to Walther H. Duisberg). U. S. 2,293,297, Aug. 18. Expressing liquid from plastic materials by means of a central threaded worm surrounded by intermeshing parallel outer worms.

INJECTION MOLDING. J. A. Muller and W. R. Tucker (to Hydraulic Press Corp.). U. S. 2,293,304, Aug. 18. A plastic injection molding machine having a hydraulic motor to move one die into engagement with the other, an injector and a hydraulic motor for the injector.

CASEIN SOLUTIONS. H. V. Dunham (to Borden Co.). U. S. 2,293,385, Aug. 18. Dissolving rennet casein in aqueous tetrasodium pyrophosphate solution and separating the clear solution from settled inorganic matter.

COATED METAL. F. R Stoner, Jr., and D. M. Gray (to Stoner-Mudge, Inc.). U. S. 2,293,413, Aug. 18. Bonding a vinyl, acrylic or methacrylic resin film, as a single baked coating, to metal with a more polar phenolic resin.

LACQUERED STAMPINGS. Georg Wick (seized by Alien Property Custodian). U. S. 2,293,420, Aug. 18. Corrosion-resistant noncracking films of after-chlorinated polyvinyl chloride are dried, without baking, on sheet metal which is then shaped in a press.

RESIN VARNISH. L. S. Engle (to Interchemical Corp.). U. S. 2,293,428, Aug. 18. A tung oil varnish containing a phenolic resin is prevented from livering by adding terpinolene.

AMINOPLAST. G. F. D'Alelio (to General Electric Co.). U. S. 2,293,454, Aug. 18. Using alpha-, beta- or alpha, beta-halogenated derivatives of secondary amides to accelerate curing of aminoplasts.

BEAD MOLDING. Orley J. Crowe. U. S. 2,293,493, Aug. 18. Forming bead molding from thin metal strip, and encasing the bead in a thin layer of a solidified plastic.

STOPLEAK COMPOSITION. R. E. Holmen (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,293,546, Aug. 18. Reacting a mono- or diglyceride with an excess of rosin and dispersing the resulting resin in water.

SCRATCHPROOF PRIMER. R. L. Overholt (to E. I. du Pont de Nemours and Co.). U. S. 2,293,558, Aug. 18. A strongly adherent nonscratching primer contains a polyvinyl butyraldehyde resin, nitrocellulose and shellac.

LAMINATED PAPER. J. E. Snyder (to Wingfoot Corp.). U. S. 2,293,568, Aug. 18. Laminating rubber hydrochloride foils to paper under heat and pressure.

CONTAINER. W. C. Calvert (to Wingfoot Corp.). U. S. 2,293,589, Aug. 18. Rubber hydrochloride film for containers is protected from embrittlement by a coating of a substance serving as a light filter.

TELEPHONE HANDSETS. F. H. Shaw (to Shaw Insulator Co.). U. S. 2,293,633, Aug. 18. Molding telephone handsets with a pair of dies, each containing a cavity for a side half portion of the set.

TRANSPARENT CLOSURE. T. H. McClain (to Lockheed Aircraft Corp.). U. S. 2,293,656, Aug. 18. A closure and mounting for safety glass in which the interlayer projects sufficiently to serve as a flexible leakproof gasket when clamped to a mounting.

FILM. A. Hershberger (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,293,673, Aug. 18. Adding up to 5 percent of a long chain dialkyl phosphate to a polyvinyl acetal resin for use in films.

PHENOLIC RESIN. Viola B. Makeever (to Makalot Corp.). U. S. 2,293,685, Aug. 18. Condensing phenol or its homologs with formaldehyde in presence of hardwood pitch.

POLYAMIDE SOLUTIONS. F. T. PETERS (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,293,760–1, Aug. 25. Linear polyamides synthesized from dicarboxylic acids and aminocarboxylic acids are dissolved in a blend of alcohol and a chlorinated hydrocarbon, or in an unsaturated alcohol.

BINDER FOR CORK. G. B. Cooke and M. S. Ebert (to Crown Cork and Seal Co.). U. S. 2,293,805, Aug. 25. Coating cork granules with an intermediate phenol-aldehyde-propylene-glycol condensation product.

NEGATIVES. Pierre Glafkides. U. S. 2,293,816, Aug. 25. Enlarging the pores of a semipermeable nitrocellulose layer in photographic film by treating first with amyl acetate and ether, then with methanol and acetone.

COATED FABRIC. G. Schneider (to Celanese Corp. of America). U. S. 2,293,855, Aug. 25. Forming a gel of a cellulose mixed ester, a plasticizer and a swelling agent, expelling the swelling agent from the gel by heat and mastication and applying the gel to a base sheet on calender rolls. *(Please turn to page 100)*

EPOXIDE POLYMERS. W. J. Toussaint (to Carbide and Carbon Chemicals Corp.). U. S. 2,293,868, Aug. 25. Polymerizing or interpolymerizing ethylene oxide or propylene oxide in contact with the corresponding glycols or their monoethers or monoesters.

FRICTION LINING. W. Nanfeldt (to World Bestos Corp.). U. S. 2,293,914, Aug. 25. Molding a slab of resin composition, faced on both sides with Cellophane, in units of specified size and baking the molded units at temperatures above 150° F.

OLEFIN-SULFUR DIOXIDE RESINS. F. E. Frey and R. D. Snow (to Phillips Petroleum Co.). U. S. 2,294,027, Aug. 25. Reacting olefins with sulfur dioxide to form macromolecular heteropolymer resins, and separating the resin from the other reaction products.

LAMINATED PRODUCTS. E. A. Calabro (to Polaroid Corp.). U. S. 2,294,159, Aug. 25. Bonding sheets of a cellulosic plastic to fibrous sheets under pressure with the aid of an organic solvent.

HOT MELT COATINGS. D. A. Rothrock (to Resinous Products and Chemical Co.). U. S. 2,294,211, Aug. 25. Blending a synthetic resin with a cellulose ether and up to 1 percent of an organic phosphite.

SULFURIZED PLASTICS. E. Tengler (to Ruetgerswerke Akt.-ges.). U. S. 2,294,217, Aug. 25. Dissolving an olefin-polysulfide plastic in the indene fraction from coal tar, or in methylnaphthalene or hydrogenated naphthalenes.

EMULSION POLYMERIZATION. G. F. D'Alelio (to General Electric Co.). U. S. 2,294,226, Aug. 25. Forming granulated hard polymers or interpolymers of unsaturated aliphatic esters in aqueous emulsion.

POLYVINYL ACETALS. E. R. Derby (to Monsanto Chemical Co.).U. S. 2,294,228, Aug. 25. Plasticizing acetal resins, for use as safety glass interlayers, with a blend of dibutyl phthalate and butyl (or amyl) laurate.

ABRASIVES. E. E. Novotny and J. N. Kuzmick (one-half each to Durite Plastics, Inc., and Raybestos-Manhattan, Inc.). U. S. 2,294,239, Aug. 25. Compounding abrasive grains with a potentially active phenolic resin and powdered magnesia.

BOTTLE CAP. J. M. Wheaton and C. A. Warner (to Owens-Illinois Glass Co.). U. S. 2,294,260, Aug. 25. A molded frangible bottle cap has a top, an attaching flange and a pair of opposite tapered bosses inside the attaching flange.

SEALING WELLS. J. J. Grebe (to Dow Chemical Co.). U. S. 2,294,294, Aug. 25. Sealing well casings with a spontaneously resinifiable liquid composition.

ACETAL RESIN. J. M. De Bell and E. R. Derby (to Monsanto Chemical Co.). U. S. 2,294,353, Aug. 25. Plasticizing a polyvinyl acetal resin with diglycol propionate phthalate.

FAN STAND. Alfred F. Fukal (to Wm. W. Welch). U. S. 2,294,399, Sept. 1. A stand for electric fans has molded plastic hoops stacked above the base to house the motor and fan.

CELLULOSE ETHER-ESTERS. H. Dreyfus (to Celanese Corp. of America). U. S. 2,294,450, Sept. 1. Simultaneously esterifying and etherifying a low-substituted cellulose derivative in presence of phosphorus pentachloride or thionyl chloride for use in making rayon, transparent foils and the like.

THERMOPLASTIC STRIPS. G. S. Hendrie (to Detroit Macoid Corp.). U. S. 2,294,555, Sept. 1. Extruding shaped strips of thermoplastic, catching the strips on a support and cooling them thereon.

ALKYD RESIN BLENDS. H. J. West (to American Cyanamid Co.). U. S. 2,294,500, Sept. 1. Dissolving a partially polymerized aminotriazine-aldehyde resin in glycerol or a monoglyceride and reacting the solution with phthalic anhydride.

HIGH GLOSS FINISH. W. M. Billing (to Hercules Powder Co.). U. S. 2,294,651, Sept. 1. Hot melt application of a blend of two different terpene-modified alkyds to form a high-gloss greaseproof, moistureproof, odorless, tasteless finish.

CARD COVERS. Lester W. Moulder. U. S. 2,294,796, Sept. 1. Protecting identification cards or the like between two plastic transparent sheets.

NEOPRENE. G. M. Hamilton (to Callender's Cable and Construction Co., Ltd.). U. S. 2,294,845, Sept. 1. Compounding chloroprene with magnesia, shellac and zinc oxide.

AMINOTRIAZINE RESIN G. F. D'Alelio (to General Electric Co.). U. S. 2,294,873, Sept. 1. Making resins by reacting melamine with formaldehyde and a chloroacetylurea.

NITROGENOUS RESINS. H. G. Hummel and M. Jahrstorfer (to General Aniline and Film Corp.). U. S. 2,294,878, Sept. 1. Making waxy to resinous condensation products of partial amides of polycarboxylic acids with long chain primary or secondary amines.

EXTRUSION NOZZLE. Max Draemann (vested in the Alien Property Custodian). U. S. 2,294,894, Sept. 8. A nozzle for extruding plastics in filament, tape or shaped strip form has an outwardly bulged wall at the orifice, which is polygonal.

INSULATED CABLE. Jesse B. Lunsford. U. S. 2,294,919, Sept. 8. Winding alternating spirals of synthetic resin and synthetic lastic around a wire conductor.

SHANK STIFFENER. E. G. Hathaway (to United Shoe Machinery Corp.). U. S. 2,294,982, Sept. 8. Encasing a solid plastic composition shank stiffener in a metal sheath.

ABRASION PREVENTION. E. H. Hilborn (to Eastman Kodak Co.). U. S. 2,294,985, Sept. 8. Temporarily protecting plastic sheeting from abrasion by a coating which gradually sublimes away when exposed to air.

MOTTLED SHEETS. Samuel B. Collins. U. S. 2,295,028, Sept. 8. Imparting decorative mottled effects to laminated sheet material with the aid of a transparentizing resin and a thinner.

NEOPRENE GEL. B. Dales (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,295,030, Sept. 8. Forming gels from aqueous neoprene emulsions by action of boric acid or a borate ester.

RUBBER HYDROCHLORIDE. R. J. Weikert. U. S. 2,295,066, Sept. 8 Shaping rubber hydrochloride into protective hat covers.

MOLDING PRESS. R. J. Kaula (to General Electric Co. Ltd.). U. S. 2,295,220, Sept. 8. A press for molding plastics has a stationary member and a rotatable member which is carried by a mold head, one of the members being threaded to thread the moldings.

CASTING FILMS. C. R. Fordyce, W. F. Hunter and K. G. Pleger (to Eastman Kodak Co.). U. S. 2,295,394, Sept. 8. Apparatus for applying a solution to a moving film-casting surface.

PROPELLER BLADE. P. Di Cesare (to Di Cesare Offset Propeller Corp.). U. S. 2,295,454, Sept. 8. Making propeller blades by compressing wood impregnated with a synthetic resin.

RESINIFIABLE HYDROCARBONS. F. J. Soday (to United Gas Improvement Co.). U. S. 2,295,612, Sept. 15. Separating resinifiable aromatic unsaturates from their mixtures with other aromatic hydrocarbons by extraction with a polyhydric alcohol.

(Please turn to page 102)

Proper Use... Proper Care... Proper Selection

NICHOLSON and BLACK DIAMOND Files for Plastics include a range of cuts and sizes of Flat, Mill, Square, Round, and Half Round; several types of X. F. Swiss Pattern (shown above) and other special types. Guarantee: *Twelve perfect files in every dozen.*

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THIS is a war in which *conservation* is as important as *production*. It applies to tools as well as to materials and products. And few tools serve more widely than files.

Plastics as well as other industries are having to get along with more and more inexperienced workers. Waste from improper file use, care and selection becomes a growing problem.

Superintendents and foremen *can* do something about it. Posting or circulating the rules of file use and care suggested at the right will help to improve the worker's efficiency, save his time, increase his output, conserve materials, reduce spoiled work, make files themselves last longer (thus conserving file steels, too).

Nicholson has literature that will prove useful as "shop-school texts." Write us on any plastics filing problem. Or on any efficiency program in which our experience with files and filing might be helpful. For your file needs, consult your mill-supply house.

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- Don't "drag" the file back under needless pressure.
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- Don't stack files against, or lay them on top of, one another.
- Keep files dry so rust will not corrode their cutting edges.
- Keep files clean of filings or shreds. After every few strokes, tap file on bench or wooden object to loosen chips. Brush file frequently with file brush or card; and always before putting file away.

NICHOLSON FILES

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STABILIZING VINYL RESINS. Emil Hubert, Herbert Rein and Karl Rössler (vested in the Alien Property Custodian). U. S. 2,295,660, Sept. 15. Improving the heat resistance of polyvinyl chloride threads by treatment with moist chlorine gas.

FINISHING TEXTILES. W. J. Thackston (to Rohm and Haas Co.). U. S. 2,295,699, Sept. 15. Padding a fabric through an aqueous dispersion of a nondrying alkyd, an alkyl acrylate or methacrylate polymer and an alcohol-modified urea resin.

WALL SURFACE. K. Wägerle (to Jacques Waitzfelder). U. S. 2,295,814, Sept. 15. Lining a wall with a plaster composition faced with plaster, then with an oil emulsion and finally with a pigmented cellulose ether composition.

ARTIFICIAL TEETH. C. H. Prange (to Dental Research Corp.). U. S. 2,295,864, Sept. 15. Artificial teeth are molded from a resin composition with a metal insert providing a cutting edge.

ALLYL ACRYLATE. C. E. Barnes (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,295,923–4, Sept. 15. Interpolymerizing alkyl methacrylates with alpha-triphenylphenyl allyl methacrylate; and synthesis of this allyl methacrylate derivative or its polymers.

FIBER PRODUCTS. R. P. Lutz (to Western Electric Co.). U. S. 2,295,958, Sept. 15. Impregnating fibrous electrical insulation with a blend of cellulose acetate and Vinsol in acetone.

FLOOR COVERING. P. O. Powers (to Armstrong Cork Co.). U. S. 2,295,969, Sept. 15. Seal coating on asphalt-impregnated felt base with a thermosetting urea-aldehyde resin.

POLYFORMALDEHYDE. P. R. Austin and C. E. Frank (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,296,249, Sept. 22. A macromolecular plastic formaldehyde polymer containing up to 5 mol-percent of an aliphatic acylethenone and up to 2 mol-percent of an organic isocyanate.

MOLDING PLASTICS. C. D. Shaw (to Wm. B. Hoey and E. D. McCurdy). U. S. 2,296,295–6, Sept. 22. Molding plasticized thermosetting resins by rapid forced flow through a narrow orifice into a hot mold; and adapting the temperature and flow of the jet so that the stream of melt stops when the mold is full.

PLASTICIZER. M. Bögemann and J. Nelles (to General Aniline and Film Corp.). U. S. 2,296,331, Sept. 22. Softening polyvinyl chloride or its interpolymers or chlorinated rubber with a di-N-substituted aminoacetic acid derivative.

ISOBUTENE POLYMERS. M. Otto and H. G. Schneider (to Jasco, Inc.). U. S. 2,296,399, Sept. 22. Interpolymerizing isobutene with other olefins (propene to pentenes) with the aid of boron trifluoride.

EMULSION POLYMERIZATION. A. Renfrew and W. E. F. Gates (to Imperial Chemical Industries, Ltd.). U. S. 2,296,-403, Sept. 22. Use of a persulfate as emulsifying agent in emulsion polymerization of vinyl compounds.

RESIN DISPERSIONS. W. Daniel and M. Otto (to Jasco, Inc.). U. S. 2,296,427, Sept. 22. Dissolving isobutene polymers in an organic solvent and dispersing the solution in water, then distilling off the organic solvent.

RUBBER SUBSTITUTE. Robert Brown. U. S. 2,296,464, Sept. 22. Making a rubber-like product from soy casein by action of chlorine in carbon disulfide.

POLYAMIDES. E. Hubert and H. Ludewig (vested in the Alien Property Custodian). U. S. 2,296,555, Sept. 22. Condensing naphthalenedicarboxylic acids with alkylenediamines to form highly condensed polyamides.

DEEP-DRAWING FILMS. R. S. McClurg and F. C. Dulmage, Jr. (to Dow Chemical Co.). U. S. 2,296,723, Sept. 22. Ethylcellulose foils for deep-drawing are double coated with a salt of a sulfated fatty alcohol.

INJECTION MOLDING. J. A. Muller and W. R. Tucker (to Hydraulic Development Corp.). U. S. 2,296,730, Sept. 22. An improved injection-molding machine having inclined guides, plungers and caps in V-shape.

REED. W. M. Peterson (to Wm. R. Gratz Co., Inc.). U. S. 2,296,737, Sept. 22. A molded plastic reed for musical instruments has rills along the tapered tip.

PLYWOOD TUBING. C. Farny (to Rudolph Wurlitzer Co.). U. S. 2,296,781, Sept. 22. Winding wood strips spirally around a core and bonding the strips with a waterproof binder under heat and pressure.

MOUTHPIECE. V. T. Hoeflich (to American Merri-Lei Co.). U. S. 2,296,785–6, Sept. 22. Mouthpieces for producing sound have reed in molded plastic piece terminating in sound channel.

MOLDED FIBER TRAY. M. P. Chaplin (to Chaplin Corp.). U. S. 2,296,808, Sept. 22. Trays made of molded fiber are reinforced by inserts along the sides.

VINYL ESTERS. L. Coes, Jr. (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,296,837, Sept. 29. Reacting acetylene with an acid, then reacting the resulting vinyl ester or another vinyl ester with methacrylic acid.

SUBMARINE CABLE. A. R. Kemp (to Bell Telephone Laboratories, Inc.). U. S. 2,296,854, Sept. 29. Insulating cables with a high olefin polymer compounded with crepe rubber.

DENTAL IMPRESSIONS. Fred A. Slack, Jr. U. S. 2,296,-877, Sept. 29. A plastic for dental impressions is made of ethyl methacrylate resin and ethanol.

CONTAINER LINING. J. M. DeBell (to Monsanto Chemical Co.). U. S. 2,296,911, Sept. 29. Containers for nitroglycerin are lined with a vinyl chloride:vinyl acetate interpolymer resin.

BOTTLE CAP INSERTS. E. C. Pitman (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,296,948, Sept. 29. Cork granules with an organic plastic binder are heated in a high-frequency electric field to set the binder.

LUMINESCENT COATING. L. F. Britten, H. G. Jenkins and A. H. McKeag (to General Electric Co.). U. S. 2,297,048, Sept. 29. Coating a vitreous surface with a methyl methacrylate baking finish containing a luminescent pigment in suspension.

OZONEPROOF INSULATION. E. Badum (vested in the Alien Property Custodian). U. S. 2,297,194, Sept. 29. Using polyvinyl chloride as filler in ozone-resisting insulation made of a butadiene:acrylonitrile resin.

PROTEIN FIBERS. Giuseppe Donagemma (vested in the Alien Property Custodian). U. S. 2,297,206, Sept. 29. Dissolving a protein in aqueous alkali, adding a phenol and ripening the protein in presence of the resulting alkali metal phenate.

SLIDE FASTENERS. Julius and Josef Püschner (vested in the Alien Property Custodian). U. S. 2,297,245, Sept. 29. Slide fasteners are made of organic plastic which can be bent to shape.

FILTER. Hans Rudolph (vested in the Alien Property Custodian). U. S. 2,297,248, Sept. 29. Making a porous product of discrete self-bonded acrylate resin or vinyl resin particles.

RUBBER SUBSTITUTE. G. F. D'Alelio (to General Electric Co.). U. S. 2,297,290, Sept. 29. Compounding a vinyl halide or vinylidene halide resin with an itaconate of an aliphatic alcohol having a cyclic substituent.

ADHESIVES. Davis M. Wood. U. S. 2,297,340–1, Sept. 29. Improving the spreadability, working life, strength and water resistance of casein (or blood) glues by adding a sulfated condensation product of ethanolamine with lauric, myristic or like acids.

Publications

Write direct to the publishers for these booklets. Unless otherwise specified they will be mailed without charge to executives who request them on business stationery. Other books will be sent postpaid at the publishers' advertised prices

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The Electron Microscope

by E. F. Burton and W. H. Kohl

Reinhold Publishing Corp., 330 W. 42nd St., New York, 1942

Price $3.85 **233 pages**

The amazing story of the development of this new tool of research is told in fascinating style by two men who pioneered in introducing the electron microscope to American science and industry. These authors make no assumptions regarding the knowledge of their readers in the realm of physics. They report that once upon a time "people saw with their eyes the things around them and a few inquisitive minds wondered how the process of vision came about." This yearning for the solution to puzzles has brought man recently to a new and astounding range of vision, 100 times as powerful as the best optical microscope. This instrument could magnify a dime to more than a mile wide, a human hair to over forty feet in breadth. It promises to reveal some of the secrets hitherto locked up in the impenetrable molecular spaces of plastic materials. This book is highly recommended to any reader who is one of those individuals who wonder how these things are done. The instructive drawings by Dorothy Stone and the many plates illustrating structures of materials as shown by the electron microscope will contribute materially to the reader's understanding of this new experimental technique. G. M. K.

Technidata Hand Book

by Edward L. Page

Norman W. Henley Publishing Co., 17 W. 45th St., New York, 1942

Price $1.00 **64 pages**

This book contains in condensed form for ready reference definitions, laws, theory, formulas and tables of data pertaining to the fields of engineering, chemistry, physics, mechanics and mathematics.

Machine Tools at Work

by Charles O. Herb

The Industrial Press, 148 Lafayette St., New York, 1942

Price $4.00 **552 pages, 435 illustrations**

This manual of modern shop practice features the more unusual classes of operations on standard machines as well as applications of the most highly developed special machine tools. Close-up action photographs, condensed descriptive matter, and speed, feed and other operating information are included. The book will be of distinct interest to apprentices, machinists, production managers and shop executives who want to be informed on advanced methods and principles which have proved successful in a wide range of manufacturing problems. G. M. K.

★ "BAKELITE LAMINATING PLASTICS" IS THE TITLE of a new 24-page booklet recently published by the Bakelite Corp., Unit of Union Carbide and Carbon Corp., New York City. Laminated plastics are defined and described, and the various types of laminated materials, including molded-laminated stock, engraving sheet stock, fluorescent and phosphorescent sheet stock and densified-laminated wood are considered clearly and briefly. The booklet is profusely illustrated with actual process photographs showing the manufacture of laminated materials, the equipment used, and their essential uses in the electrical, automotive, aircraft and chemical industries. Included also is a useful table of properties of laminated phenolic plastics, giving tensile, flexural, compressive and dielectric strength, as well as moisture absorption figures, dielectric constants and loss and power factors. Copies of this booklet are available to business executives upon request.

★ "RUBBER GUIDE BOOK FOR AMERICAN WAR INdustries" is the title of a new 30-page booklet from the B. F. Goodrich Rubber Co., Akron, Ohio, designed to present maximum information in condensed form. Listing the properties and application of products using natural, synthetic or reclaimed rubber, the fully illustrated manual is divided into 11 indexed sections under the following headings: Properties of Ameripol, hydraulic equipment parts, sponge products, industrial rubber gloves, extruded goods, anode rubber covering, industrial and aeronautical molded goods, hard rubber parts, rubber cement, lathe cut goods, properties of reclaimed rubber.

★ A 4-PAGE CATALOG DESCRIBING THE UNIVERSAL Slotmaster manufactured by Experimental Tool & Die Co., 12605 Greiner Ave., Detroit, shows little change in this attachment for milling machines during the past year except the provisions made for a more convenient adjustment of the length of the stroke, and a revision of the bearing design of the ram to compensate for wear.

★ A FOUR-PAGE FOLDER ON CELERON MOLDED Plastics has just been made available from Continental Diamond Fibre Co., Newark, Del. The Bulletin, MP-42, discusses the general characteristics, chemical resistance, thermal properties, and average properties of this new development, and includes a variety of interesting application photographs depicting a variety of uses for this material.

★ THE BRISTOL CO., WATERBURY, CONN., HAS JUST published a new bulletin (No. T302) on its line of fully compensated liquid-filled recording thermometers for temperatures between −125° F. and +400° F. The bulletin contains detailed information regarding construction of the instrument, the various forms in which it is available and its application and use.

★ BULLETIN NO. A-330 ISSUED BY THE FOXBORO CO., Foxboro, Mass., explains in detail the theory and performance of a new control function recently developed by that company called Hyper-Reset. Tests are included demonstrating the action of Hyper-Reset in re-establishing process stabilization following an upset.

★ A USEFUL LITTLE BOOKLET CALLED "CHEMICALS from Coal" has just been issued by Koppers Co., Tar & Chemical Division, Pittsburgh, Penna. The booklet consists of a series of data sheets which present the physical and chemical properties of those chemical compounds available from the Koppers Co., which are derived from coal tar.

★ AN 8-PAGE BULLETIN RELEASED BY ELASTIC STOP Nut Corp. Union, N. J., announces price reductions in 415 items of their anchor, gang-channel and instrument-mounting types of elastic stop nuts. The catalog numbers of all items covered, together with old and new list price, are tabulated for reference.

ERIE RESISTOR PLASTICS *Supplant* VITAL WARTIME MATERIALS

PHOTO BY U. S. ARMY SIGNAL CORPS

THE machine gun parts illustrated above, are but a few of the plastic articles now being used in the manufacture of the actual fighting tools of war. Almost every day molded plastic products are replacing vital metals and other critical materials needed in the production of other war equipment. The use of this synthetic material has proven so successful in the replacement of various metals, wood, leather and other basic raw materials that correctly molded plastics is no longer considered as a substitute or a temporary, wartime expedient. Erie Resistor's many years of successful experience in custom extrusion and injection molding puts them in excellent position to meet the exacting specifications of today's wartime requirements for high quality plastic products. If you are confronted with a problem of replacing critical material for wartime applications call upon our engineering department for assistance in its solution. We will gladly make recommendations for adapting your products to plastics.

ER *Plastics Division* ER

ERIE RESISTOR CORPORATION, ERIE, PA.

Washington Round-Up

Current news, Government orders and regulations affecting the plastics industry, with analyses of the plastics situation

OPERATING SUPPLIES

The War Production Board has made it easier to get maintenance, repair and operating supplies for companies not working under the Production Requirements Plan. As a number of molders have not qualified under the plan, this is of interest to the plastics industry.

Ratings for maintenance, repair and operating supplies may now be extended in any month up to 10 percent of the cost of production materials to which the same ratings are extended during that month, plus the cost of production materials obtained without priority assistance to which the same grade of rating could be extended during the same month if priority assistance were needed. Those using this new system must note, however, that if they are seeking maintenance, repair and operating supplies which would fall under the metals list of priorities Regulation No. 11, such supplies may not exceed $2^1/_2$ percent of the cost of production materials.

Users of this new plan are no longer restricted to extending ratings only for such operating supplies as would be actually consumed in processing production materials to which the same ratings were applied. Under the new plan, ratings may be extended to all operating supplies used directly for processing production materials, as well as to obtain items for repair of machinery and equipment used in manufacturing the production materials.

Maintenance or repair of building or office supplies do not fall within this new system and ratings may not be extended to cover such items. On the other hand, ratings may be extended to obtain materials such as small hand tools, which have been generally considered as operating tools and which were excluded previously.

In the case of plastics fabricators, if the material to be processed is furnished by the customer, the cost of such material to the customer must be used instead of the cost to the processor as a basis for computing the allowable percentage of rating extension. Also in such a case the month in which the processing order is placed is used as a base date rather than the month in which the material to be processed is ordered.

PHENOL USAGE FOR CLOSURES

The granting of AA-5 ratings to closure manufacturers operating under the Production Requirements Plan for phenolic closures has again caused considerable speculation within the industry since phenol is reported so scarce. A check by MODERN PLASTICS divulges that this rating is being given quite generally to manufacturers of civilian items who have applied for PRP ratings. It is understood that the forthcoming end use order governing phenol usage through allocations discussed by Frank Carman, Chief of the Plastics and Synthetic Rubber Section, WPB, at the SPI Convention held Oct. 12 and 13 at Rye, N. Y., will practically prohibit the use of phenol for closures even on an AA-5 rating. There will be some exceptions to this, but in those cases the molder will have to demonstrate clearly why material other than phenol could not be used.

ACETIC ANHYDRIDE UNDER ALLOCATION

Because demand for acetic anhydride exceeds current production, the chemical has been placed under a system of allocations, it was announced by the Director General for Operations. General Preference Order M-243, effective Oct. 30, prohibits delivery or use of the chemical except as directed by WPB. The standard chemical allocations forms, PD-600 and PD-601, will be used by persons seeking authorization to make and accept deliveries. Acetic anhydride is used principally in the manufacture of cellulose acetate (which, in turn, goes into plastics and parachute cloth), pharmaceuticals, vitamins and explosives. Deliveries and use of 54 gallons or less in any one month to any one person are exempted from the order.

• • •

Thermoplastic Order M-154—The effective date of this Order has been postponed from October 1 to November 1, pending revision of some of its provisions to provide proper control for all types of thermoplastics, due to the increased military demands.

• • •

Die Castings—Producers of die casting were recently given by the OPA a speedy procedure for determining prices of castings of designs or metallic compositions not sold in March 1942—base pricing month of the General Maximum Price Regulation. Under GMPR, a die caster who could not determine his maximum price on the basis of highest price he or his closest competitor charged during March 1942, had to apply to OPA for authorization to determine his maximum price and for instructions regarding the method to follow. Order No. 84 provides instead that a die caster unable to set a maximum price under Section 2 shall apply the same pricing formula or method of calculating prices which he would have used on March 31, 1942. He is to use material costs, manufacturing costs, allowance for plant and administrative overhead, and margin of profit used Mar. 31, 1942.

• • •

Vinyl Polymers—Polyvinyl butyral has been included with all other vinyl polymers in the allocation control exercised over such products by WPB's order M-10. A previous order, M-154-a, applying to the polyvinyl butyral, was revoked.

• • •

Priorities Regulations—Nos. 3, 11, 12 governing the extension of preference ratings, use of ratings by companies under the Production Requirements Plan, and rerating have been amended in several respects. The amendment to Regulation No. 3 provides a more flexible procedure for the extension of preference ratings to obtain operating supplies by companies not under PRP. A corresponding amendment has been made in Regulation No. 12. Under Regulation No. 11 as amended, companies operating under the PRP are given the privilege of extending ratings served on them instead of using the ratings assigned on their PRP certificates to obtain materials which are not included in the materials list accompanying the PRP. This change is intended chiefly to allow extension of ratings for obtaining parts and sub-assemblies, since the materials list is confined chiefly to raw materials.

• • •

Advisory Committees—The Division of Industry Advisory Committees announced the formation of four new industry advisory committees, among which are a Pyroxylin and Vinyl Resin Coated Paper and Fabric Industry Committee, with E. H. Bucy, Chief, Protective Coatings Section, Chemicals Branch, as the Government Presiding Officer; and Thermosetting Plastics Processors Industry Committee, with Frank H. Carman, Chief, Plastics and Synthetic Rubber Section, Chemicals Branch, as the Government Presiding Officer.

<u>THERE'S</u> THE SPOT FOR A *PLASTICS* APPLICATION . . . AND HERE'S A GUIDEPOST TO COSTS!

When Molded Plastics seem to provide the answer to your problem, there's one *best* way of figuring costs. Select a thoroughly competent molder . . . take him fully into your confidence . . . and let him submit his figures.

PIECE COSTS FOR VARIOUS MOLDS AND QUANTITIES

	1 Cavity Hand Mold	6 Cavities Hand Mold	12 Cavities Hand Mold	24 Cavities Hand Mold	24 Cavities Semi-Auto Steam Mold
Approximate Daily Production	80	500	925	1,730	4,500
Cost of Mold	$140.	$560.	$940.	$1,670.	$1,890.
Piece cost per 1,000	185.	46.	32.	23.	22.
Total cost mold and pieces, per 1,000 in: 1M quantities	$328.00	$606.00	$972.00	$1,693.00	$1,911.00
5M "	213.00	156.00	220.00	357.00	402.00
10M "	199.00	102.00	126.00	190.00	211.00
25M "	190.60	68.00	70.00	90.00	98.00
50M "	187.80	57.00	51.00	58.00	60.00
100M "	186.40	52.00	41.40	50.00	41.00
500M "	185.28	47.12	33.88	26.35	22.90

He'll want pretty detailed information. A blueprint with dimensions and tolerances, of course. Probable quantities, to determine mold capacity. Type of finish desired. And full understanding of the proposed use of the part, for selecting the correct material. These factors all influence cost.

For your guidance, here's a table showing the relationship between required production, mold capacity and individual piece costs for a compression molded job. We've selected a hypothetical piece, but figures are actual. We can submit such figures based on an actual part — your part — just as well.

Finally, consider quality carefully in comparing mold costs. Good molds . . . built by experienced tool-makers . . . deliver from 20% to 50% more pieces in a given time than a poor one. They deliver pieces with better finish . . . reflect generally lower piece costs. And that's our kind of work!

Right now, of course, our production is pretty thoroughly devoted to Uncle Sam. But the forward-looking companies . . . those who are planning development and design with us . . . will find business brighter in the future.

CHICAGO MOLDED PRODUCTS CORP.

CHICAGO MOLDED PRODUCTS CORPORATION

Precision Plastic Molding

1046 NORTH KOLMAR AVENUE, CHICAGO, ILLINOIS

COMPRESSION, INJECTION, TRANSFER AND EXTRUSION MOLDING OF ALL PLASTIC MATERIALS

Machinery and Equipment

★ THE DEVELOPMENT OF D-M-E STANDARDS (above), by Detroit Mold Engineering Co., Detroit, Mich., is described by the manufacturer as a new idea in preparing dies for injection molding of plastics. It is said to save considerable time preliminary to production because a master drawing supplied with each carries all of the details of the D-M-E Standard. Designing of the base is thus eliminated and the work of drawing in cavities expedited. Savings of material costs are also claimed because the units are so simplified in design that most of the component parts may be used again and again in other structures. All parts are jig drilled, which makes them interchangeable and makes possible replacements from stock at any time.

★ A SPECIAL MIXING UNIT WHICH IS DESCRIBED AS incorporating in one mixing tank three means of agitation—kneading, blending and absorption—comes from L. O. Koven & Brother, Inc., Newark, N. J. The container is an all welded tank with dished bottom, made of steel or any other metal, with an outside jacket which may be provided for heating or cooling the product during the mixing process. The cover is gasketed or bolted to the tank, and is provided with a manhole which can be opened by turning a hand wheel. The agitating mechanism consists of a vertical shaft, the upper terminus of which is coupled to a speed reducer driven by a motor. A three blade, adjustable ship-type propeller is mounted half way down the length of the shaft. At the bottom end, there is a turbine type propeller, and the tank itself has four baffles projecting radially in four quadrants along the cylinder, but mounted several inches away from the cylinder wall.

★ A NEW TYPE MSD RESPIRATOR SAID TO PROTECT the wearer from inhaling harmful dust is now available from the De Vilbiss Co., Toledo, Ohio. The unit is held in place by a head band, and is adjustable to the wearer's face. The body of the respirator is soft molded rubber, with double lip cushion ridges. Inhalation is accomplished through louvres which open downward from the bottom of the cylindrical front housing. Air passes through a folded filter, through a centrally placed inhalation valve of thin rubber.

★ NEW MIXING AND GRINDING MILLS MANUFACTURED by Paul O. Abbé Co., Little Falls, N. J., are now available with both blades and bowls in various types of metals to solve the different problems that arise in industrial production. The power range is from 1/4 h.p. to 25 h.p., and they may be either pulley or direct motor driven. Gears and stuffing boxes are enclosed to safeguard operator and to facilitate keeping the mechanism clean. Mixers of this type are now being used in the manufacture of smokeless powder, blackout paint, nitrocellulose, plastics, rubber and asbestos compounds, among others.

★ GEORGE SCHERR CO., INC., 128 LAFAYETTE ST., New York City, has recently developed a new inspection instrument (below) which they call Comparitol, said to check parts to an accuracy of 1/10,000 in. The part to be inspected is set on the table, the measuring head holder bracket adjusted and locked into position, and the table moved to bring the pointer to zero on the scale. With this instrument parts may also be checked for roundness or taper. This instrument has a 9-oz. standard measuring pressure which can be increased or decreased to meet individual needs.

STOKES "*Standard*" MOLDING PRESSES

For War Production . . . For Post-War Economy

Improved Automatic Time-cycle control, a new "Slow-Close" Device, perfected toggle action and other improved and exclusive features of design and construction make these presses ideal equipment for today's production requirements . . . in many plants preferred equipment for Army and Navy work, precision molding, parts with thick and thin sections or delicate inserts, including gauge cases, condensers, etc., as well as for general molding work.

These presses increase output, save every second, afford more heats per hour, eliminate human error, produce uniformly high quality moldings with minimum rejects. They save molding labor, molding material, mold wear and tear. They reduce machine and mold maintenance to negligible figures.

For more facts and figures and complete description of these presses, write for new Catalog No. 427 . . . just off the press.

- **Automatic, Except Loading and Unloading**
- **Skilled Labor Not Required. One Operator Can Tend Several Machines**
- **Ideal Molding Action . . . Fast in the Clear, Slow in the Mold, with Precise Automatic Control of Final Closing Speed**
- **More Heats per Hour. Increased Production, High Quality Moldings. Fewer Rejects**
- **Ideal for Precision Molding, Insert Work, Parts with Thick and Thin Sections . . . All Other Work in Which Closest Accuracy Must Be Maintained**

F. J. STOKES MACHINE COMPANY
5934 Tabor Road, Olney P. O. Philadelphia, Pa.

Representatives in New York, Chicago, Cincinnati, St. Louis, Cleveland, Detroit

Pacific Coast Representative: L. H. Butcher Company, Inc.

F.J.Stokes MOLDING EQUIPMENT FJS Est. 1895

In the plastics picture

★ FIRST TO BE HELD IN WARTIME IS THE 12TH ANnual All-America Package Competition, entry blanks for which are now available from *Modern Packaging* magazine, 122 East 42nd St., New York City.

Because progress in packaging can contribute to the stepped-up economy of America at war, the editors of *Modern Packaging* feel that now, more than ever before, every company in the field should keep abreast of what is being done in the industry. All those active in the packaging field, and the general public as well, will want to know how the industry has adapted itself to 1942 conditions along such lines as finding substitute materials, adopting simplified designs and eliminating unnecessary waste.

Judges for the Competition will be William M. Bristol, Jr., Bristol-Myers Co.; Bessie Beatty of radio fame; Lucian Bernhard, pioneer package designer; Standish C. Marsh, J. Walter Thompson Co.; and Ray M. Schmitz, General Foods Sales Co. Complete information on conditions of the competition may be procured from the editors of *Modern Packaging*.

★ THE ARMY-NAVY "E" AWARDED TO THE EMployees of the Boonton Molding Co., Boonton, N. J., was formally presented on November 4. An account of the presentation ceremonies will appear in the December MODERN PLASTICS.

★ THE ARMY-NAVY PRODUCTION AWARD WAS PREsented to the directors, officers and personnel of the Victory Plastics Co., Hudson, Mass., for an outstanding war production job. (See page 66, this issue, for description of bayonet scabbard which was the basis for this award.)

★ THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS announces the election of Harold V. Coes, vice-president of Ford, Bacon & Davis, Inc., to the presidency of the Society for 1943. Vice-presidents elected to serve two-year terms on the Council of the A.S.M.E. were Joseph W. Eshelman, president Eshelman & Potter; Thomas E. Purcell, general superintendent of power stations of the Duquesne Light Co.; Guy Shoemaker, vice-president, Kansas City Light & Power Co.; Walter J. Wohlenberg, professor of mechanical engineering, Yale University.

The new officers will be installed during the 63rd annual meeting of the Society scheduled for November 30 to December 4 at the Hotel Astor in New York.

★ THE CELANESE CELLULOID CORP., 180 MADISON Ave., New York City, announces the formation of a new department to be known as the Technical Sales Service Division. Millard Demarest, formerly director of sales of the Lumarith Molding Materials Division, will head the new department, whose function will be to service industrial plants unfamiliar with plastics that are using the company's Lumarith material.

Mr. Demarest will be succeeded by W. Raymond Porter, now head of the Washington, D. C., office, who will take over the job of Director of Sales of the Lumarith Molding Materials Division.

★ THE PACKAGING INSTITUTE, INC., ANNOUNCES that its annual convention is scheduled for November 5 and 6 at the Hotel New Yorker, New York City. Packaging in wartime will be the subject of the program discussions.

★ THE ANNUAL MEETING OF THE ASSOCIATION OF Consulting Chemists and Chemical Engineers, Inc., was held at the Chemists Club, N. Y. C., October 27, 1942. The meeting took the form of a symposium entitled "The Consulting Chemist and Chemical Engineering in War and Peace." Wm. J. Schepp of the Schepp Labs., Inc., was the speaker of the evening, with an address entitled "The Consultant and Industry or the Practical Catalyst."

★ MINNESOTA PLASTICS CORP. ANNOUNCES ITS removal to new quarters at 388 Wacouta Street, St. Paul, Minn.

★ A. G. YORK, VICE-PRESIDENT IN CHARGE OF sales of the Watson-Stillman Co., Roselle, N. J., has just been appointed a member of the WPB Valves and Fittings Committee.

★ THE DEPARTMENT OF CHEMISTRY, McGILL University, Montreal, Canada, is offering, for the fifth consecutive year, an extension course on the Chemistry and Technology of Resins and Elastometers. The course has been planned especially for industrial chemists, fabricators and sales promotion men, and will be given by Dr. R. V. V. Nicholls, Assistant Professor of Chemistry.

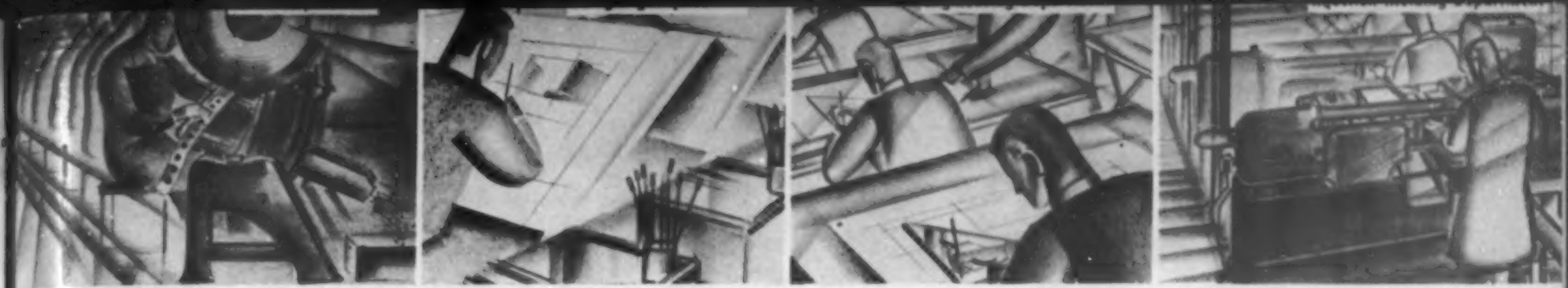
★ SEAMLEX CO., INC., MAKERS OF FLEXIBLE ALLmetal hose, announce that their enlarged plant and offices are now located at 27-27 Jackson Ave., Long Island City, N. Y.

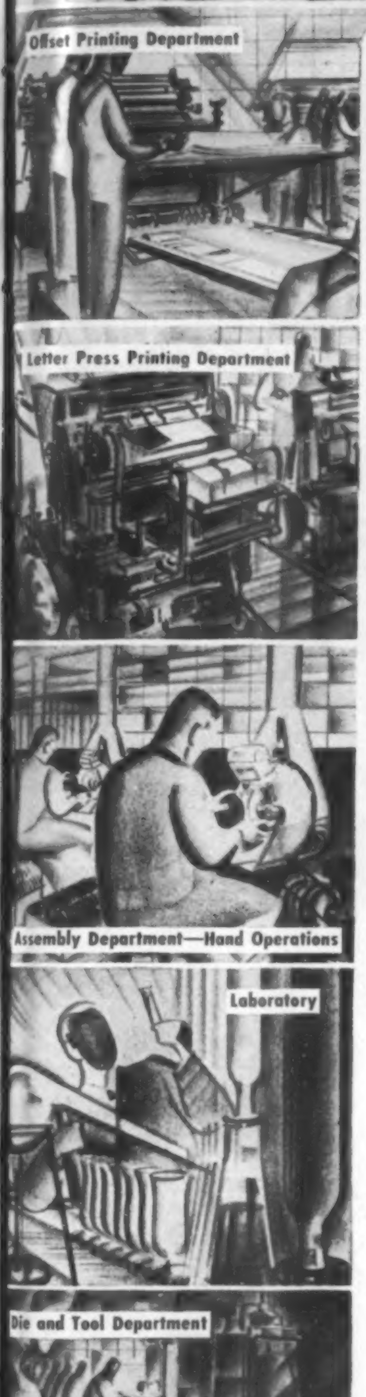
★ "WARTIME CHEMICALS FROM NATURAL GAS" was the subject of an address given by Dr. Gustav Egloff, president of the American Institute of Chemists, at a testimonial dinner given him on Oct. 23 at the Chemists Club, New York City, by the N. Y. Chapter of the Institute. Other speakers on the program paid tribute to Dr. Egloff's many contributions to chemical knowledge. Dr. E. H. Northey (Calco Div., American Cyanamid Co.) Chapter chairman, presided.

★ BALL & JEWELL ANNOUNCE THAT THE NEW 2-story brick building to be attached to their present quarters at 22-28 Franklin St., Brooklyn, N. Y., will be completed Dec. 31. The additional space, the company says, will provide added facilities for production of the plastic scrap grinders they have been supplying since 1895.

★ ACCORDING TO AN ANNOUNCEMENT FROM THE American Cyanamid Co., New York City, new economies in the manufacture of clothing issued to the U. S. Armed Forces are expected following the acceptance by the Army Quartermaster Corps of a new melamine plastic molding compound for buttons on all garments required to meet the most severe service conditions. Melamine plastic is said to be extraordinarily resistant to destructive agencies, and has been approved on the basis of service tests for laundering, sewing, strength, stability of color and sterilization. The economic advantages of using buttons from this material are described as 1) lower costs because of elimination of machining operations required to make buttons of other materials; 2) materials required are domestically available in ample quantities; 3) hand labor is eliminated; and 4) the buttons are completely uniform.

★ R. H. MACY & CO., INC., HERALD SQUARE, NEW York City, is now planning an exhibit to be held early in 1943 which will show present-day developments in American industry, their part in winning the war and raising morale on the home front, and their anticipated contribution to the postwar economy. To make the presentation truly comprehensive, the company is eager to secure detailed information on all substitutes, synthetics, replacements and improvements in all industrial fields—both those in current use and those promised for the peacetime future—and will welcome data or suggestions.




Offset Printing Department
Letter Press Printing Department
Assembly Department—Hand Operations
Laboratory
Die and Tool Department


COMPUTER
TRUE AIRSPEED
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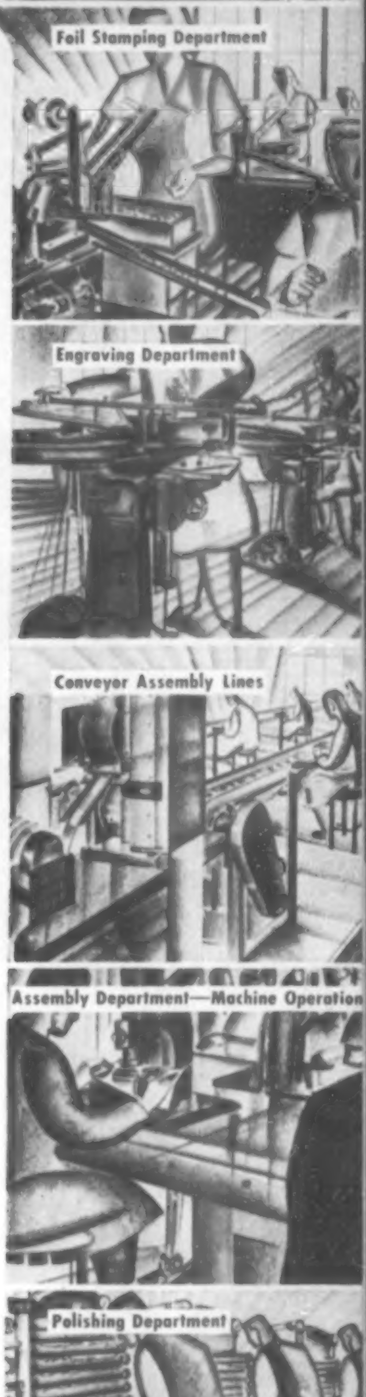

Foil Stamping Department
Engraving Department
Conveyor Assembly Lines
Assembly Department—Machine Operation
Polishing Department


Spraying Department
Modeling Department
Inspection Department
Extrusion Molding Department

Hardwood pitch extender

EARLY in November 1941, just before Pearl Harbor, the old Office of Production Management issued General Preference Order M-27 to conserve the supply and direct the distribution of phenols. That order has had a tremendous effect upon plastics production and upon every plastics molder. The shortage of phenol has been so acute as to limit even production of essential war items. New molding compounds and materials which will minimize the amount of phenol necessary are thus of prime importance to the industry.

One of the most recent developments of this nature is a new group of materials designated as K. E. M., covered by U. S. Patent No. 2,293,685. K. E. M. is a line of thermosetting compounds formulated with varying amounts of phenol and hardwood pitch ranging from No. 8, which contains 4 percent phenol, to No. 62, which has a 20 percent phenol content, to No. 100, which uses no phenol whatsoever. This last composition is therefore free from Government control.

The basic raw material upon which these compounds are built is a hardwood pitch from which tarry materials that are volatilizable under usual commercial conditions of distillation have been removed. Such a pitch is the non-volatile residue from the fraction of tarry material used in the Suida process for the extraction of acetic acid from pyroligneous acid. In this process, the pyroligneous acid is extracted with the highest-boiling fraction of wood tar obtainable in the destructive distillation of wood. After the extraction has been accomplished, the tar is heated to volatilize the extracted acetic acid and other low-boiling materials present. Finally, the tar itself is distilled to give a tar distillate and leave a residue which is known as pitch, formerly a waste product of little commercial value, but currently functioning as the modifier of this composition.

Varying proportions of pitch may be incorporated in the phenolic resins, the exact proportion being contingent upon the precise properties desired in the finished plastic material. A relatively large proportion of pitch is used when a softer plastic is desired, and a smaller proportion when a harder end product is being sought. Ordinarily the proportion is from 25 to 60 parts (by weight) of the pitch to 100 parts of the finished plastic material, but for hard plastics the proportion may be as little as 10 parts of pitch, and for very soft plastic the pitch may be increased to 90 parts.

Little or nothing is known of the precise chemical structure of these pitches or resins, but a typical specimen shows the following characteristics:

Loss on heating	.799%	Iron	.181%
Ash	.2%	Water	.301%
Benzol soluble	90%	Flash point (open cup)	451° F.
Acetone	98%	Fire point (open cup)	500° F.
Copper	.045%	Melting point	92–100° F.

This new molding compound is described as rather slow curing, and is said to produce parts of limited or reduced physical strength; but in applications where accelerated curing and a high degree of physical strength are not of paramount importance, this material may serve as an adequate replacement, since it can be made to yield a striking likeness to the phenolics.

The compound may be blended with odd lots and leftovers of phenolic compounds, lignin resins and compounds of reground flash, since in the main, Government specifications for essential war orders definitely prohibit the use of reground flash. Hence the quantities of flash and rejects which will inevitably be accumulated as residue from Government orders might be used to advantage as a component of K. E. M. 100, and used for such purposes as the individual molder believes will be suitable—that is, end products requiring limited physical strength characteristics.

The new material can be furnished in a complete range of plasticities, the hardest showing rather superior curing qualities and the softest capable of being blended with large proportions of ground flash, and still retaining sufficient plasticity to be adapted both to compression and to transfer molding methods.

The physical characteristics of the material, such as impact strength, water resistance, heat resistance, etc., are subject to modification after the manner of true phenolics—by the addition of either fillers or plasticizers—but to a lesser degree.

This new development is at present limited in its color range to black, brown, a natural unpigmented shade of dark brown and dark mottles. However, its comparative independence of Government-controlled ingredients, and its adaptability for such applications as closures and other packaging applications formerly filled by the phenolics, may frequently outweigh the color disadvantages.

Credits—Makalot Corp.

Laminated phenolic bearings

(*Continued from page 76*) developed by oil lubricated babbitt and about one-fifth the friction of water lubricated babbitt. This last figure emphasizes the loss in power which results in a babbitt, bronze or bronze and babbitt bearing when water dilutes the oil used for a lubricant. In many locations in different types of equipment, it is practically impossible to keep the water out.

Resistance to impact or hammer blows is a necessary quality in heavy duty bearings subject to intermittent loading. The results of hammer-blow tests, comparing laminated plastics and other bearing materials, are as follows:

Test—A 1-in. cube of each material was subjected to 8000 hammer blows of 24.2 ft.-lb. each.

	Thickness		
Material	*Before test*	*After test*	*Compressed*
Plastic Grade M Base	.9965"	.993"	.0035"
Plastic Grade B Base	.9998"	.992"	.0006"
Phosphor Bronze (80–10–10)	.9999"	.980"	.0019"
Lignum Vitae (End Grain)	.9999"	Fractured at 630 blows	
Quebracho Wood (End Grain)	.9999"	Fractured at 1150 blows	

Bronze or babbitt metal is composed of hard crystals embedded in a soft matrix. Properly lubricated, these cushioned crystals carry the bearing load very well. Under unfavorable conditions, when the lubricant becomes thin or fails, or some other trouble arises that causes the bearing to run hot, these hard crystals tear at the shaft; and as the heat rapidly increases, the softer matrix of the bearing recedes and the con-

No time for blind man's buff

We offer ALL plastic processes — for war contract work
That means unbiased cooperation — with only one AXIS to grind

Are you in doubt about *which* plastic process, *or processes*, are best adapted to your war needs? We urge that you let us help you decide, for here, *all* plastic processes are available.

We also offer capacity and equipment . . . engineering and designing . . . mold making and molding . . . finishing and assembling, if needed. It's a compact organization . . . a complete service, including a machine shop manned by expert craftsmen. Favorable labor costs enable us to meet price specifications or limitations.

Uncle Sam says that we can't tell you about what we are already doing, but one of our plants is 100% engaged in war work. Full conversion is our goal. Send blueprint, sample or details. We'll get an estimate to you as fast as humanly possible and, if any of your work comes our way, we'll deliver it when promised.

LEOMINSTER PLASTICS CORP.

LEOMINSTER, MASSACHUSETTS

INJECTION · EXTRUDING · COMPRESSION · TRANSFER · HOLLOW MOLDING AND FORMING · SHEETS · RODS AND TUBES · SPECIAL SHAPES

3—Shells of various thicknesses made of the laminated phenolic material. Note 2-piece construction at right

dition becomes worse. The result is usually a badly scored shaft unless the machine is shut down at once.

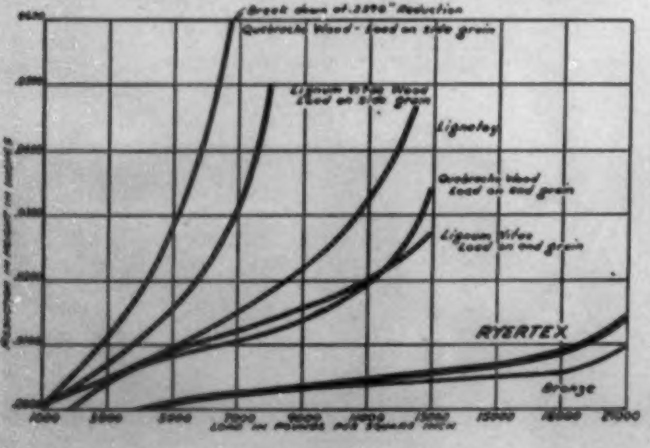
With plastic bearings, there are no hard crystals to score the shaft and the worst that can happen is a carbonizing of the surface fabric *which results in more rapid bearing wear but without damage to the shaft.* As the plastic bearing is such a poor conductor of heat, only the immediate surface of the bearing is affected, and there is no complete breakdown as in the case of a babbitt bearing. Fortunately when things go wrong, the plastic gives off a pungent, distinct odor, which is easily detected by the operator.

The plastic bearing is practically non-absorbent and unaffected physically by the water, oil or other ordinary solutions which may come in contact with it. The fabric is so completely saturated with the resin that only the fibers on the immediate surface can retain any of the lubricating medium. Therefore, the bearings undergo no change or deterioration whether idle or in service.

While there exists a general standard formula for laminated plastic bearings designed to meet a wide range of applications, there are, of course, variations of either fabric or resin which offer physical characteristics particularly well suited to certain operations. These special compositions are recommended only after a complete study of the job. The bearings are regularly made in sizes from 1 in. to 30 in. in diameter and in thickness from $^1/_8$ in. up. However, special sizes and types are also made to order.

Plastic bearings have an almost universal application. In paper mills, steel mills, cement mills and other industries where power consumption is a large item, their use is very desirable from a power saving standpoint. In other fields where bearings are subject to acid conditions or where a bearing insulation is required to prevent electrolysis between parts

4—Compression test chart shows breakdown point of laminated phenolic bearings to be over 37,000 pounds



PHYSICAL PROPERTIES

Specific gravity	1.37
Weight per cu. in., oz.	0.8
Modulus of elasticity, p.s.i.	1,500,000
Tensile strength with grain, p.s.i.	9400
Tensile strength across grain, p.s.i.	7000
Compressive strength, flat, p.s.i.	37,500
Compressive strength, edge, p.s.i.	25,000
Bending strength, p.s.i.	18,000
Water absorption in 100 hr., %	1.07
Scleroscope hardness	75
Max. operating temp., °F.	275
Thermal coeff. expansion	30×10^{-6}
Dry coeff. of friction	0.280
Permanent set per 1 in. thickness under load of 1000 p.s.i.	.002

as in some pumping conditions, or where bearings do not receive regular attention as in farm equipment, the laminate serves well. Plastic bearings, besides being specified for new equipment, also play an important part in modernizing older equipment by reducing power consumption in the bearings and thus increasing the capacity of the machine.

Examples of heavy duty service

Steel mills have bearing conditions subject to maximum strains, excessive temperatures and difficulties in lubrication. Therefore, the following examples taken from mills where plastic bearings have been installed are indicative of what may be expected from the laminated material.

Application: 10-in. continuous mill, rolling small shapes. Finishing stand. Size of neck, 7 inches. Speed: 600 to 800 r.p.m. Service: 20 to 40 times that of bronze and babbitt combination. Power saving: 17 to 25 percent, depending on section rolled. Lubricant: water. Comment: trouble due to stalling motors completely overcome.

Application: 10-in. continuous strip mill. Bearings placed in all stands and spindle carriers on this mill. Power saving: 35 percent. Lubricant: water. Comments: management had contemplated the purchase of 300 additional h.p., which was unnecessary after plastic bearings were installed. They had also tried some stands of roller bearings and found that the power saving secured from the plastic bearings was comparable to that secured from roller bearings, particularly when the cost of installation and time to change rolls was considered. It required two hours to change a roller bearing stand; to change the plastic bearing took only about half an hour. With the plastic bearings installed they had no difficulty in holding gage or rolling lighter gage. Stalling motor trouble was entirely eliminated.

Application: 19-in. sheet bar mill. $^3/_8$-in. plastic liners. Length of service: have rolled 97,000 tons with only $^1/_{32}$-in. wear. Lubricant: water. Comment: improvement in holding gages, elimination of grease and longer life.

Application: 28-in. continuous strip mill in all 6 finishing stands and 6 roughing stands. Roll necks 20-in. in diameter, 18 in. long. Rolling gages from .134 to .062. Widths up to 27 in. Speed: 95 r.p.m. Length of service: the plastic bearings have rolled 120,000 tons and are still in service. Annual power saving, grease saving, and labor saving in production were in excess of $25,000. Power saving was approximately 37 percent.

Credits—Material: Ryertex, registered trademark of Joseph T. Ryerson & Son, Inc., for bearings manufactured of material supplied by Continental-Diamond Fibre Co.

SPI fall convention

(*Continued from page 80*) of products made from plastics which could be placed in the exhibit.

W. H. Howard, of R. H. Macy & Co., told of a plan which Macy's has to present forcefully and dramatically the story of what new products are being developed of interest to consumers. According to a survey made by General Electric, he said, 75 percent of the population wants to know about this research.

"To tell this story," Mr. Howard revealed, "Macy's will stage an extensive exhibit some time early in 1943. Over 50,000 square feet of space, on the 5th floor of the new building, will be devoted to the exhibit. Present plans call for a dramatic and colorful 'world's fair' atmosphere—utilizing plastics and synthetics for the entire decorative scheme. The exhibit area will be subdivided into various classifications, such as the home, food, transportation, communication, business, apparel, etc. Space will be provided in each section for special exhibits and demonstrations.

"There will also be a 280-seat theatre in the exhibit area where lectures, motion pictures and more important demonstrations will be featured on the daily program. This exhibit will be many shows in one. The growing importance of plastics will be recognized by its presence throughout most sections of the exhibit."

According to Mr. Howard an attendance of over a million people is expected.

"A limited number of industrial concerns," he told the convention, "will be invited to discuss the subject of having special exhibits within this demonstration. Adequate space will be provided to such firms having an interesting and dramatic story to tell the public. Such exhibits can include any or all of the following classifications:

(a) New ideas in replacement merchandise, now available for marketing.

(b) New ideas already created, but which have been frozen for the duration.

(c) New and imaginative ideas for the future."

In closing, Mr. Howard invited any interested firms to discuss the exhibit with him and expressed his admiration for "the magnificent job your industry is doing."

Executive vice-president's report

W. T. Cruse, executive vice-president of SPI, closed the general meetings by giving a report on the activities of the Society since the last meeting. He revealed that SPI now has a Canadian Unit which resulted from conferences in Canada and New York City with the Canadian plastics industry. Mr. Cruse then covered briefly the activities of the Button Section in establishing superiority of molded plastic buttons with the Quartermaster Corps; the work of the Technical Committee in collective technical activity; and the problems of obtaining sufficient tool steel for molds and tools and brass for inserts. Mr. Cruse closed with the discussion of the new Washington Service of the SPI and the publicity activity of the Society, and thanked the entire staff of SPI for their cooperation in furthering the work of the Society.

Technical meetings

The theme at the various technical meetings was the impact of the war on the plastics industry. Priority controls, price controls, Army and Navy buying, materials problems and all of the factors accentuated by the war effort were discussed in detail.

Molders Section—A long discussion was held in the molders meeting as to the setup of the Molders Committee. A resolution was introduced and passed to keep the Committee intact and apart from SPI. The M-25 and the M-158 orders were influenced by the Molders Committee according to its chairman, Alan Fritzsche, and he revealed that they were assisting in the draft of the new order for control of phenols.

Button Section—Captain Edwin L. Hobson, of the Army Quartermaster Corps, told the compression molders of buttons that there would be no more vegetable ivory imported for the duration of the war under a directive from the War Shipping Board, which is allowing 3000 tons to come in during the transition period from vegetable ivory to plastics. Captain Hobson said that it was necessary, therefore, for the Army to know the total capacity of a plant per shift per style so that it could determine production reserve on any particular type of button which might be needed in a hurry.

The button group elected a Questionnaire Committee to formulate a questionnaire to elicit this information. Members of the committee are: Neil Broderson, Rochester Button Co.; H. Newman, Button Corp. of America; Stanley R. Borel, Patent Button Co.

The button group is scheduled to reconvene early in November to form three committees on thermosetting buttons, thermoplastic buttons and casein buttons.

Machinery Section—A rather thorough discussion of the problems of getting pumps for compression equipment was carried on in the Machinery Section. It was the general consensus of opinion among the machinery men who attended the meeting that Vickers, Inc., should license other manufacturers to produce this pump in sufficient volume to take care of necessary requirements. No formal committee was appointed to do this contact work. F. G. Schranz, Baldwin Southwark Div., Baldwin Locomotive Works, said he was going to get in touch with Vickers, Inc., and suggest such an arrangement.

Another suggestion was that, although the pump situation was serious, the machinery group should first find out from Washington whether they would be permitted to continue to build plastic molding presses. After thorough discussion, the consensus was that the manufacturers would still be allowed to build presses but not so many 4-, 6- and 8-oz. capacities. It was also stated by one manufacturer that he thought if pumps could be gotten they could get an A-1-A priority to make injection machines.

Technical Committee Report—Frank Warner, Chairman of the Society of the Plastics Industry's Technical Committee, reported on the progress the committee has made since the May 5 meeting of the Society. Mr. Warner detailed the setup of the various new committees and divisions within the Society and praised the work of the special committee on optics in the development of plastic coverings for binocular bodies. He also told of a meeting at the Naval Aircraft Factory in Philadelphia on June 10, 1942, to discuss materials and processes for the inexpensive production of large laminated aircraft parts.

On June 30 and July 17 demonstrations were held at the Naval Aircraft Factory showing production methods and the construction and function of these non-structural parts. Company representatives present were asked to undertake the application of plastics to as many parts as possible, according to Mr. Warner's report.

On August 3, 1942, a meeting of the committee on laminates was held in Cincinnati, Mr. Warner said. There was talk about the proposed classification of plastics and proposed Federal Specifications.

Mr. Warner then told of a meeting held at Philadelphia on July 14 of organizations interested in a classification system for plastics. Activities of this organization were reviewed and a start made toward the agreement on one classification system, which eventually resulted in a preliminary draft of a system which was submitted to the various organizations for consideration. This system was submitted to the Technical Committee by letter ballot. As a result, two members approved, one member did not approve, one member did not vote, three members have not yet returned the ballot.

In conclusion, Mr. Warner divulged that the Resin Adhesives Division has prepared a manual of assembly gluing which is being turned over to the publications division for publication and that the Thermoplastics Division is completing a survey

of extruded plastic tubing, initiated at the request of the Naval Aircraft Factory, which will also be turned over to the Publications Division for publication.

Thermosetting Division—Discussion in the thermosetting group centered around the Signal Corps work, and it was charged that the Corps was requiring unnecessarily high-polished finishes on telephone handsets. The representative of the Signal Corps said that he would look into the matter, also that he was eager to get some written data to give to Signal Corps inspectors to aid in checking on curing time, mold temperature, etc., wherever Signal Corps plastics were being molded. A committee was appointed to attempt to get this data together.

Thermoplastic Division—At this meeting, the principal point of discussion was the thermoplastic order, which has not yet been made effective. A number of suggestions were made but no definite conclusions were reached.

The main business carried on in this section was a review of the Committees' actions to date. A survey of the industry was given to the Naval Aircraft Factory in Philadelphia as to the possibilities of substituting plastics for aluminum in canteens. A survey was also submitted to the Naval Aircraft Factory with reference to the use of plastics for parachute grip cord housings. It was brought out that both the Army and Navy requested information as to the various stock shapes and sizes which can be obtained in extruded material.

Committee on Laminates—The Committee on Laminates reviewed the action as reported by Frank Warner on the proposed Federal Specifications for Plastics. Mr. Warner read a letter from Robert Burns, A.S.T.M. Section D20, commenting on these specifications.

Considerable discussion was held on the investigation of laminates by the Naval Aircraft Factory and the getting of additional samples and test data to the Naval Aircraft Factory. The test data will embody properties of various laminates at $-70°$ F., $+77°$ F. and $+160°$ F. The properties to be checked are tensile strength, compression strength, flexural strength, water absorption, dimensional stability and bearing strain.

Resin Adhesive Division—At the Resin Adhesive meeting, the principal business conducted was to finish the business still pending in connection with the publication of the glue manual to be published by SPI. New business discussed was preparation of similar manuals on other phases of gluing. This discussion centered around manuals for hot press gluing and low pressure gluing. Resin adhesive specifications were also discussed.

History of a register

(Continued from page 73) nearly all the holes used for assembly were drilled after molding. Self-tapping drive screws were used in the entire assembly. The completely assembled unit, with the cover in the open or load position, is shown in Fig. 9. The large projection on the upper inside portion of the cover is a large spring clip which acts as a lock when the cover is closed. The unit can easily be unlocked through a molded slot in the bottom. However, due to the location of this slot, there is no danger of inadvertently unlocking the unit during normal use.

This is the engineering history of substituting plastics for metal. It has clearly demonstrated the ability of plastics not only to substitute for strategic materials but, in many cases, to replace them permanently. Plastics have not merely enlisted for the duration. Because they are light, economical, easy to assemble, permanent in finish and goodlooking, they have won for themselves an assured position in the postwar world.

Credits—Material: Durez. Molded by Kurz-Kasch, Inc., for Standard Register Co.

Cold molding preforms

(Continued from page 78) there is always some slight variation in the preforms which may be compensated for either by breaking off a corner of an overweight preform or by adding a small piece from another to bring the weight of a small one up to the correct amount.

This cold preform mold was designed with "more than ample" loading space. This eliminated any stuffing or tamping in order to get the full load of loose material into the mold. With all of these improvements, a molder now makes a complete cold molding cycle as follows:

First, he scoops the material from the drum into the measuring container and dumps it into the cavity of the preform mold in one complete load, tamping being unnecessary. He then closes the mold on "high" for a few seconds, opens it, and removes the six preforms which have been knocked out automatically.

Not only has this method of cold molding preforms greatly speeded up plant operations, but General Electric Co., which originated it, reports that the cost of each preform has been cut by more than 75 percent.

FEDERAL SPECIFICATIONS

It is important that the plastics industry know when plastic materials are allowed under Government specifications. Modern Plastics *magazine is now getting copies of all Emergency Alternate Federal Specifications and will publish them regularly as a service to the industry.*—Ed.

E-LLL-R-191a, Receptacles, Wastepaper; Fiber, Office and Lobby. Under date of September 25, 1942. The above receptacles may be made from hard vulcanized fiber or plywood.

• • •

E-W-B-411, Blasting Apparatus (Machines, Blasting; Galvanometers and Rheostats for Testing Blasting Circuits and Machines). Various nameplates may now be made from graphic chart plastic or other suitable material. Panels for binding posts and resistance units shall be of suitable plastic composition.

• • •

GG-C-101a, Calender Pads and Stands. The stands shall be of metal or plastic material. Plastic material stands shall be not less than .070 in. thick.

• • •

E-GG-C-466, Clocks; Synchronous-Motor (for) General Purposes. Unless otherwise specified, type II cases shall be made of a non-metallic molded material such as fiber, woodpulp or pressed wood fibers.

• • •

E-GG-S-776, Straightedges; Steel. The straightedges shall be furnished as specified in the invitation for bids. Specifications for type II call for plastic. Two classes in type II are: A, solid; B, with transparent edges. Note: Requirements for these plastic straightedges are rather severe.

These are emergency specifications and were prepared by the Federal specifications Division in collaboration with the WPB. Companies interested may purchase copies of the above printed specifications and amendments if desired, from the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 5 cents each. Emergency Alternate Federal Specifications may be obtained from the Federal Catalog Division, Room 6109, Procurement Division Building, 7th and D Streets, S.W., Washington, D. C.

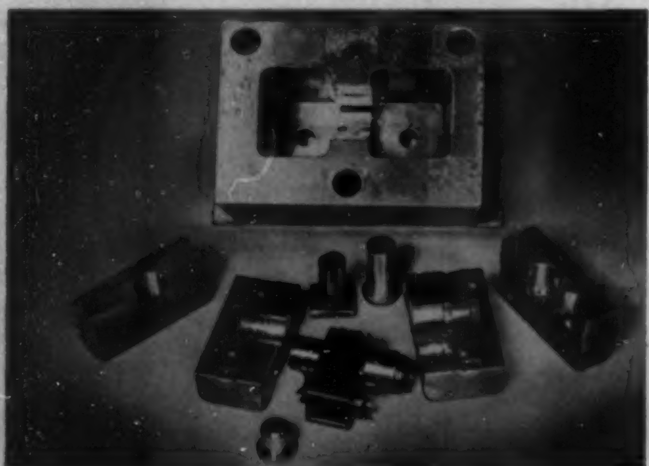
Molding an airtight meter

(*Continued from page 51*) phenol-formaldehyde molding composition to flow freely, and fill out the two long projections on the sides. The second problem was to develop a control of the suction force which was created each time the top of the mold was removed, causing the rectangular barrier in the center and the half barrier in one of the round holes to bulge out of shape. The center barrier must be held to minute tolerances because the timing device or clockwork depends on the plastic material for its bearing surface. The clearance between the fan and the sides of the piece required the half baffle to be flat and smooth without the slightest bulge or contour deformation. Since the action of the fan must be correlated exactly with human breathing, there must be no warpage and holes for the bearings must be accurate. There could be no smallest margin of error in a mechanism upon whose proper functioning might depend the life of the wearer.

All of the problems were resolved and the obstacles overcome by the development of a single-cavity mold which has seven removable parts. All parts are removed after each molding cycle and reassembled when the new cycle is started. The body of the timer is molded in one piece, while the other four parts (covers and rings) which complete the unit are formed separately in a four-cavity hand mold.

The meter mechanism is so small and the teeth of the worms and gears of such minute dimensions that they must be precision fitted in order to mesh. Inside dimensions are held to within .002 in., without warpage, and the parts assembled must be absolutely airtight, which is one reason for molding the body of the timer in one piece. Before shipment, meters are tested under water with air pressure to make absolutely certain that there are no leaks which would admit the gases against which the respirator is designed to protect the wearer.

5—Single-cavity mold for body of timer has 7 removable parts which must come out each time the mold is run. 6—Splits which hold body in mold cavity come in 4 parts



For the material, a hard, moisture-resistant, general purpose phenol-formaldehyde molding composition with a smooth surface finish was selected. Performance records are reported to be demonstrating that on both scores, material and mold, the job is a complete success.

Credits—Material: Resinox. Molded by Oris Manufacturing Co. Manufacturer: Willson Products, Inc. Clockwork and timer assembly: H. C. Thompson Clock Co.

Economics of molding

(Continued from page 92)

and d $$\frac{2.04}{60} \times .02560 = .00087$$

The factor b is $\dfrac{6 \text{ sec.}}{2.04 \text{ min.}} = 4.9$ percent

The labor cost per cycle has been calculated assuming labor at 55 cents per hour:

$$\frac{2.04}{60} \times .55 = .01870$$

The number of presses that can be attended by one operator is determined by examining the "open" time in relation to the "cure" time, and is subject to some cut and try in case the economical number of cavities results in too great an open time for him to attend the number of presses predicted.

It will be noted that the automatic presses are shown operating a greater number of hours than the semi-automatic machines. This is based on experience, which indicates that it is perfectly feasible to operate automatic presses unattended; and takes into account the average length of time they have been found to operate during the unattended shift.

Table III.—Summary of Molding Costs

	Part A	*Part B*	*Part C*
Quantity to be produced	500,000	120,000	40,000
Semi-automatic press			
Optimum number of cavities	7	4	2
Mold cost per part	.00446	.01502	.01540
Press cost per part	.00477	.01237	.01674
Labor cost per part	.00345	.00269	.00506
Total	.01268	.03008	.03720
Automatic press			
Optimum number of cavities	6	4	2
Mold cost per part	.00385	.01502	.01540
Press cost per part	.00411	.01078	.01566
Labor cost per part	.00015	.00045	.00068
Total	.00811	.02625	.03174

Conclusions

The reduction in costs by automatic molding averages 21.4 percent for the three parts.

The major saving is the result of the tremendous reduction in labor possible with automatic presses.

In the cost summary (Table III) it will be observed that the extra cost of the automatic press is more than offset by the charge for the greater length of time that the semi-automatic press is in use, due to the longer open interval required to remove parts and reload.

Reducing breakage

(Continued from page 81) plastic dishes hold over crockery:

1) The plastic tableware weighs 10 percent less than the crockery it replaces.

2) When packed for shipment, it effects over 30 percent saving of space.

3) Due to the careful consideration given to the design of this tableware, the space needed aboard ship for storage is less than 50 percent of that occupied by crockery.

4) Both the design and the color of the melamine dishes add to the attractiveness of meals served Navy men at sea and on shore.

Credits—Material: Melmac and Plaskon Melamine. Molded by Hemco Plastics Div., Bryant Electric Co., and Northern Industrial Chemical Co.

Fabrication of polystyrene

(Continued from page 79) combination of the two are:

1) Time
2) Waste
3) Cost
4) Physical properties
5) Design

To show how these factors should be balanced to determine the best method of procedure, take a completely theoretical example:

Figure 3 shows a theoretical unit to be made from polystyrene. The apparent requirements are, briefly, 150 units needed in 15 days and 2000 per month thereafter. The total number specified in the original commitment by the customer is 20,000.

The production engineer now poses certain questions, such as: Should this unit be made by machining, by injection molding or by a combination of both? Will the physical properties of the machined unit be the same as those of the injection molded unit? Will there be any change in design after manufacture has started? How much can be spent on producing the unit?

Experience with many case histories has shown that the logical method of obtaining the best possible answer to these questions is to draw up a graph showing the relation of cost to quantity produced which will result from the use of each method. This has been done in Fig. 2 for the theoretical piece shown in Fig. 3.

The economics of the two methods are:

Machining	*Injection molding*
Tool charge, $150	Four-cavity mold, $3200
Cost per unit, $1.05	Cost per unit, 36 cents
Delivery, 800 per week	Delivery, 6–8 weeks for mold
Tooling, 1 week	1000 per day production

The logical conclusion to be drawn from this example is that it would be better to make the 150 parts by machining and put these into use at once. Field tests will show any need for redesign, change of material, etc. Providing change is not necessary, an injection molding die can be started. Meanwhile, machined units can be made until such time as the molded parts are being produced in sufficient quantity to handle the production requirements. In this instance, the injection parts would start flowing in about two months, resulting in a total cost of approximately $13,263, or nearly $3000 more than would be incurred had the unit been made entirely by injection molding. However, the method would allow for surety of design, practical tests of use and early delivery schedules without too high original costs.

With regard to change in physical properties, it should be noted that so long as machining is done on stabilized rod, the pieces will be less likely to crack in service than the injection molded pieces, but otherwise will be nearly identical.

Naturally, there may be a fairly high loss of material in a machined piece, and this is one of the major causes of high cost in this method of operation. However, with machinists skilled in the handling of polystyrene, the loss from rejected pieces is very low and the scrap can usually be used to manufacture parts for other than electrical uses.

With screw machine parts, such as coil forms, tube spacers and miscellaneous small insulator parts, the number of units which can be made most economically by machining is greatly increased. Of course there are a great many pieces so complicated in nature as to require machining rather than injection technique. In these cases, it has been found that molding will be the best method of manufacture after the piece has been tested and redesigned. It is also quite obvious that where only 50 to 1000 units will be required, there will usually be a great saving in metal as well as in cost if the article is made by machining.

In summation, it is necessary to point out that machining of stabilized polystyrene is relatively easy; and that in most cases where design changes and quick delivery are major factors, it is advantageous to use machined pieces at least in the early stages of production.

Costs in war work

(Continued from page 70) plastic materials involved in new and important war applications. This naturally results in a very heavy development load and, of course, many uses on which considerable development money is spent are simply uneconomical substitutions of plastics for other materials more critical. In many cases, the development money spent cannot be returned, as is normally the case, by continuing use of the material for the application over a long period. To cut costs of development work as well as production costs, it seems to me that since plastic materials are so vitally important as replacements for more critical materials, a joint Army-Navy technical committee on plastics could be advantageously set up to decide:

"a) What plastics are suited for various war applications?

"b) Determine the approximate amount of material needed and ascertain availability from WPB.

"c) If the application is a logical one for a certain type of plastics which, upon investigation, seems to be available in adequate quantities, then select one of the best molders or fabricators to cooperate with the manufacturer of the material involved. Offer a development contract and give the best informed people in the plastics industry an opportunity to test the selected material thoroughly for the application. Draw up specifications that will fit both the application and the material and then negotiate a trial contract with one or two molders or fabricators.

"After the above experimental program has been con-

cluded, additional contracts could be negotiated with any number of qualified molders or fabricators who could be then given some information on the material to use and the technique to use which had produced the desired results in the experimental program. Currently there is too much of everyone trying to work on the development of everything. Such a procedure is bound to cause confusion and to increase costs."

Short runs

Another thing which has caused considerable trouble has been short runs. "If the runs are short," reads a typical answer, "we may have $1000 worth of tools and $200 worth of pieces and we are never sure of getting the business a second time because someone else may quote a lower price which means no repeat business. . . . We have tooled up for certain items, our customer having gotten a Government contract. The second time, our customer may not be the lowest bidder and that means again many hours of toolroom work without the resultant production we must get to keep our plant operating. We have made more tools since the war started than we used to make during a two-year period *and yet our production equipment is idle.*" (Emphasis supplied.)

Another molder expresses it differently: "In our experience, a small job is usually unprofitable because of the fact that the setting-up work required is the same as on a long job. The same number of tools and dies and molds are usually required. The cost must be absorbed over a smaller number of pieces and, therefore, short-run jobs are usually unprofitable. New fixtures are required in order to meet new jobs and such changes interrupt the continuity of long-run production."

The smallness of initial orders causes trouble, according to many molders, laminators and fabricators. "As a general rule," one explained, "the initial orders are for very small amounts and require considerable very close supervision. All these factors tend to increase our production costs. On some jobs where we have a long production run resulting in proportionately less supervision and a much greater volume of business, our factory costs (material and labor) may run as low as 60 cents per pound. *On some war production runs our factory costs have run in excess of six dollars per pound.*" (Emphasis supplied.)

Several molders said that short runs were not a bothersome factor with them. One of them stated quite cheerfully, "We are willing to go along producing experimental parts and making short runs to prove applications. We think this is beneficial to the industry as a whole from the long-pull angle."

Perhaps the general feeling is summed up best in a letter from an eastern manufacturer: "A contractor who has demonstrated that he can supply a perfectly satisfactory product should be given a contract of correct size to run his particular equipment under optimum conditions and should be assured of materials allocation to keep it running until his contract is complete. In many cases at the present time, however, runs are short and costly either because of too many contracts awarded him or hand-to-mouth doling out of raw materials."

Many other factors were brought to the attention of the editors, among them increase of labor costs, filling out report forms, increase in clerical forces, sharp rise in traveling expenses, division of authority and priorities difficulties.

Divided authority

"One of the most serious difficulties that we have encountered," one manufacturer said, "has been that of division of

authority and interest in certain departments. An article will be started under the supervision of Capt. X. Before long we get an inquiry or criticism from Lt. Y, and the matter goes along from one official to another until we are so confused that we hardly know which is which. We would certainly like to know at all times the one individual with whom we are to deal on any particular contract. It would save countless hours and hours mean money."

The same sentiment was expressed a bit differently by another molder: "In a general way, war work is cumbersome as one cannot deal with one responsible individual. The Government appears to be a many-headed monster and it is very difficult to find the particular head to give one the answer required in order to solve the many problems which come up. In addition to this, we find the red tape in connection with Government work to be a serious nuisance. We have to make out a great number of reports for many various Government Departments. Such reports include surveys of manpower, machine capacity, hours of machine operation, etc. In so far as we can tell we have never received a single order which resulted from the reports we have made and we, accordingly, feel that the reports are worse than futile, as some of our best production men have been transformed into amateur statisticians and clerks in order to fill out the necessary papers."

Clerical additions costly

"Additional overhead," said still another molder, "imposed upon us by the necessity of having extra clerical help to keep up with the additional paper work imposed through priorities regulations, issuance of priorities and the following of countless other Government regulations has been the most outstanding problem as far as our work has been concerned."

There were several complaints about the necessity of frequent conferences with Government officials in demonstrations which, in order to show good-will and maintain good-will, have had to be handled with a great loss of executive time.

The labor situation has also been a source of cost increase. The current situation on the labor costs, one manufacturer charged, "is by far the most potent factor in the increase of costs. Shortage of skilled help resulting from lack of opportunities during depression years to train more employees, has been aggravated by the loss of men to the armed forces. Desperate need for more and more production requires that employees work overtime at time and a half rates and of course labor cost estimates must reflect this."

Reports a burden

Rather wearily, a midwestern molder replied, "I suppose you are tired of reading about the innumerable reports and forms it is necessary for modern business to fill in to supply the apparently endless appetite of the various Government agencies. Sometimes it is impossible to believe that these reports can be of any service whatsoever."

Glad to make the sacrifice

The most outstanding note in all letters was the universal willingness to put up with every inconvenience and difficulty if it contributed to winning the war. Without exception every letter received in answer to Modern Plastics' questionnaire had a statement that anything necessary to the war effort was all right. Typical of this feeling are the following:

"The appreciation, however, that we have for the need of production to accomplish our task of defeating the enemy encourages us to overlook all the bad aspects and work harder for the accomplishment of our purpose."

"By and large," said another, "we have gone through the usual process of a republic going to war. We spend the first year fighting each other and ultimately get around to licking the enemy. I believe, however, that most of us today are more anxious to clean up this war as soon as possible than to do business normally and are more than willing to make the required sacrifices which, of course, are only temporary."

"I think it is of prime importance," said a midwestern molder, "for us to constantly remember that we are fighting a war and we cannot afford to fight among ourselves. Our whole feeling is that these things are necessary to promote the war effort and I believe our industry cheerfully and willingly accepts these conditions."

What to do about it

To know of these pitfalls is a big factor in avoiding them. But mere knowledge is not enough. Aggressive action must be taken based on that knowledge.

Each molder, laminator or fabricator has his individual problem growing out of the particular situation in his own plant. However, there are certain broad rules of reason which, if adapted to those individual situations, will help out Government contract costs.

First, on rigid inspection there are many things which can help get a product passed by the Government inspector. Go back to the mold room and show the molder why pieces are rejected. Make certain that they know it's costing money and could even mean forcing you out of business.

Try to find out where your pieces are going to be used and do a friendly job of educating the inspector to the usage so he will resolve doubt in your favor. It is to the advantage of the inspector to pass every piece which he knows will work under the conditions it will face. Get to know him as a human being, not just as a rejecting mechanism.

You must impress every production employee with the necessity of doing the best job of which he is capable. A good method, which has been used to advantage by one molder, is to display rejected pieces in the department responsible for their rejection. Put a piece improperly and poorly finished in a prominent position in the finishing department. Place molded parts which didn't pass muster because of a molder's carelessness in conspicuous places throughout the mold room.

On short runs, employee cooperation can pay big dividends. The time-worn suggestion box idea rarely gets results. But a cooperative production committee with employee and managerial members can come up with astounding ideas for short cuts and product improvement.

Mold costs are fairly inflexible. However, you can protect yourself by determining intelligently whether to assume such costs. Discard any ideas that you will get repeat business on a mold made for a particular war job. Just figure the job as a unit and see if it will pay for itself. If it won't, don't take it—with one exception. That exception is to take a money-losing job if it means a foot in the door for other contracts which will keep you going. Naturally, it's a gamble and one where you have to determine the odds. But if you decide the odds are not too long, better not pass up work.

Proposals

Design changes can be modified sometimes through factual and intelligent handling. When a change comes or is in the wind try to get a hearing so you can present your side of

the picture. Remember, if you can show that such a change will seriously impede output, then you may get a break.

A final warning is not to get discouraged or angry because of the red tape you will encounter or have already experienced. The Government runs a tremendous business—the largest in the world. It is fundamental in the business world that when a plant reaches a certain size it becomes inefficient to make it any larger. But Government is a sort of massive giant standing spraddle-legged over all industry. Therefore delays, buck passing and at times seemingly inexcusable inefficiency are going to be encountered. Just keep on plugging and shrugging it off. A sense of humor even in these grim times will prove invaluable. Exercise it and be friendly and as cooperative as you can. The result will be that you will work out many of the headaches of Government business to your own benefit.

Plasticizers

(*Continued from page 89*) vinyl or acrylic monomers. Similar molecular effect is seen in the oil-soluble curing types of resins, as, for example, the butyl ether groups on the urea resins used for industrial finishes.

In the unsaturate copolymer expansions which the country is now undergoing, it is probable that continual use will be made of this principle but it is also likely that huge quantities of standard low cost liquid plasticizers will continue to be used as modifying agents.

Supply

At the time of writing (August 1942), the plasticizer supply under war economy is reasonably ample. Phthalates are generally available for essential civilian uses; and camphor or esters derived from vegetable oils are in fair supply. Tricresyl phosphate has been tight because of its enormous cable uses but a considerable number of reserve plasticizers have been developed so that there does not appear to be any urgent shortage for worthwhile end uses. Future supply will depend considerably, of course, on the results of many developments now under way, but the War Production Board through its plasticizer specialist appears to be in position to advise adequate plasticizer supply for any reasonable demands which may appear in the plasticizer industry.

Injection molded parts

(*Continued from page 43*) The front section of the heater, in turn, screws into the heater body.

The nozzle of the unit (screwed into the front section) is continuously cooled by water. When the plunger pressure is applied, extreme heat is momentarily generated at the nozzle, and the material is thoroughly plasticized as it flows through the nozzle into the sprue, runners and die cavity. After the brief application of intense heat, the nozzle is at once cooled by the water, and consequently the material in it does not set up, but remains plasticized and ready for the next shot.

The actual setting of the molded material takes place very quickly in the heated mold cavity. The piece is then removed from the die by the operator, as in conventional thermoplastic molding.

A description of this unique attachment should not be con-

cluded without a few remarks about a novel heat exchanger unit which is offered for molding thermoplastics. It is not recommended that the same cylinder be used both for thermosetting and for thermoplastic materials because of the danger of contamination. However, the same machine and equipment (except for the front section of the heater) may be used for both. The availability of this heat exchanger naturally increases the scope of work that a custom molder can handle with a minimum investment in equipment.

In view of the new materials now appearing which will not stand prolonged exposure to excessive heater temperatures—particularly the new rubbery thermoplastics which will become increasingly prominent—these features are very timely. The front section of the standard conversion unit is replaced with a part called a heat exchanger. In the main body of the heater the material is merely kept warm—not enough heat is introduced to break it down.

At the time of injection, when the pressure is applied, heat is introduced to the nozzle area which quickly plasticizes the material during its passage to the mold. Since continuous cooling is applied after the shot, the nozzle area at once becomes cool enough to prevent decomposition of the material. It should be noted that the new molding powders which are sensitive to prolonged heat may be obtained in a wide range of hardness from jelly-soft to almost glass-hard. At the present stage of development, it is fair to say that the whole range of the new polymers may be molded successfully in this type of heater, as may all thermoplastic materials. A minimum of corrosion-resistant metal is needed for constructing a heater of this type for the new plastics, which is a further recommendation for the wartime adoption of this molding method.

Mold construction

Molds used with this process are relatively simple affairs. They consist of the conventional two halves, often with hardened or plated inserted cavities, and sufficient knockout pins to ensure removal of the piece without distortion. It is desirable to have the molds made to accommodate standard electric heaters.

Wherever possible, molds of standardized diameter should be used. They are of uniform length so that the time taken to change from one job to another is materially reduced. This is a vital factor in a custom molding plant doing war work, where schedule changes cannot be predicted.

The light weight of these round molds is important because it saves valuable time in die manufacture (a lathe instead of a shaper may be used), and conserves metal. Finally, it avoids wear and tear on the molding machine, especially at present high production speeds.

Many molds made for this process are constructed to handle inserts, which are firmly held in the closed mold when the material is injected. There is none of the shifting or loosening which occasionally occurs during mold closing and causes a costly percentage of rejects.

Special high production features

To facilitate insert molding, the machines are equipped by the manufacturer with a special die plate stop valve which permits the operator to stop the die plate at any point in its travel in either direction. As the dies open, the ejectors knock out the molding. As the molds begin to close, the operator throws the special valve which stops the die plate for the placing of inserts. These, of course, cannot be put in place when the die is in full open position because the knockout pins are then pushed forward by the ejector rod. Operators

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of the machines have observed that this valve is also of considerable help during mold changes, in addition to making possible the use of the simplified dies described above.

Another feature of many converted injection molding machines is the use of a centralized water control station, which is placed waist high and to the right of the control panel. The operator thus can make every required running adjustment on his machine without moving from his position.

Both the pressure and the return lines are centered in this water control, the former leading from a pressure box, while the latter return to a special open drain. Thus flow and temperature of each separate line may be quickly observed and regulated. Only two main water lines are required per machine, a supply and a drain. This does away with the familiar "Christmas tree," or maze of piping usually observed on molding machines.

The dense structure and the consistent quality of injection-molded thermosetting plastics are calling the attention of electrical and aeronautical engineers to this method of continuous injection molding. Since this process is not supplanting any existing molding method, but is bringing to the front a new molding art which increases the scope and versatility of plastics processing, its future appears unlimited.

As wartime plastics engineers more and more frequently turn to this new process for their exacting requirements, it is safe to predict that the specifications of tomorrow's designers will often read: "Injection molded of thermosetting material."

Taps for brass

(***Continued from page 63***) the signals got mixed, and nobody could discover which notes came from the brass and which from the plastic. This would seem to have proved that the volume of the two didn't differ materially, and again the plastic bugle had passed.

One step remained in this Trial by Ordeal: the plastic bugle needed to have the musical tone approval of the Commanding Officer of the U. S. Army Band, who interrupted a rehearsal to listen to the brass vs. plastic competition. It was right out of *Die Meistersinger*—a plastic Prize Song ringing out over the Beckmesser of brass....

After it had been established that the Army issue bugle wasn't an unusually poor sample procured expressly for the occasion, and after a high-priced bugle had been brought in for more competitive blowing, the plastic got the nod. Its tone was pronounced superior and its musical qualities good. The bugler announced that it seemed a little easier to blow—and by this time he was well qualified to judge!

The molding company is now at work on tools for quantity production of the bugle, and reports that molds will be of unusual construction, with cores pulled on a radius. It is likely that the instrument will be molded in several parts and cemented together.[4] If this plan is followed, the splitting up will be done in such a way that nothing will interfere with the air column when it is assembled. Except for the wall thickness, the finished plastic bugle will duplicate the brass version, with the regulation Army tuning slide running from G to F.

The antiquity of the bugle as a means of calling signals is undisputed. The earliest bugle (that used at the siege of Jericho, for example, when the walls came tumbling down) was a cow's horn; and the word bugle itself derives from *bucculus*, the Latin diminutive of *bos*, or ox. Its use was general throughout the Middle Ages. The mediaeval hunts-

[4] **An article on the mold construction and molding of the plastic bugle will appear in the Engineering Section of an early issue of MODERN PLASTICS.**

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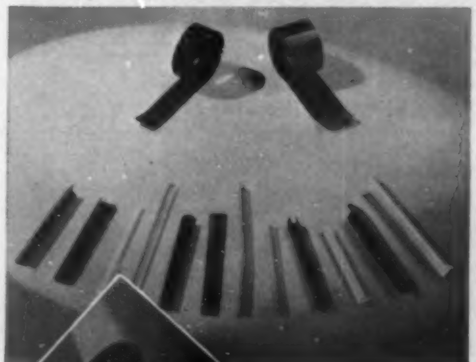

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man signalled the devious flight of his quarry with a bugle-horn (still used wherever hounds meet to this day); it rallied the feudal knight to his lord's standard, heralded victory in battle, sounded Roland's last sad call in the Valley of Ronces-valles.

In the 17th Century, the British Army bugle replaced the drum for signalling, and with the Army it has remained ever since. Modern warfare gives it no place on the field of battle, but the soldier knows it intimately; and whatever its tone or carrying power, or whether it be brass or plastic, the sergeant will still complain that it can't get them up in the morning.

Bagasse molding compounds

(*Continued from page 65*) resin developed from non-essential chemicals. This material is semi-thermoplastic and at present must be chilled somewhat before ejection from the mold. It is only about two-thirds as strong as the thermosetting compound, but is unusually resistant to water, mild alkalies and acid and some organic solvents. It has been found possible to obtain very fast molding cycles with this compound, since the degree of chill required is not more than 50° F., and no cure is required beyond the short period necessary to close the mold. It can be molded in ordinary flash type molds such as are commonly used for phenolics, and does not require more than the normal amount of molding pressure. Development of this material is still in progress and results to date have been very encouraging.

Credits—Material: Valite

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Plastics under vibrations

(*Continued from page 88*)

3. The cyclic stress accompanying a dynamic test disturbs the structure of a material by cold-working or "fragmentation." In metals cold-working causes a relatively minor change in the modulus of elasticity. In plastics, however, high cyclic stress may evidently cause considerable fragmentation in the structure of the material, and the modulus of elasticity may be greatly reduced. The modulus of rigidity of the canvas-laminated plastic, *C* of Fig. 6, for example, was reduced from 414,000 to 337,000 p.s.i. (temperature effects corrected) by alternating torsional stress of ±3000 p.s.i. maintained for about 40,000 cycles.

4. The determination of the static load-deflection curve of a material proceeds slowly enough to permit the assumption that the specimen is always at room temperature. The static modulus of elasticity is thus essentially the isothermal or constant temperature value, if the room temperature is assumed constant. During the longitudinal vibrations, however, the alternating strains occur too rapidly to allow thermal equilibrium to be attained, and the vibration is adiabatic, or constant heat in nature. This adiabatic state requires the specimen to go through cyclic temperature changes at the

same frequency as the vibration; cooling down with increasing volume (or stretching) and heating up when compressed. These temperature changes cause contraction and expansion in the specimen, and the effective or adiabatic modulus is slightly higher than the isothermal value (18). For the materials considered in this paper the adiabatic modulus is less than 1 percent higher than the isothermal modulus.

The total deviation between static and dynamic moduli of elasticity caused by all four factors mentioned is but a few percent for the metals tested. The fact that the dynamic modulus of metals decreases slightly with stress is of some practical importance in spring design. If very accurate instruments and a special technique are employed, static tests also show a decrease in modulus with stress (6) of the same order of magnitude as dynamic tests. In plastics, however, the first three factors discussed reduce the dynamic modulus considerably as the stress increases. Figs. 6 and 7 show that the static moduli of elasticity of plastics may be 40 percent higher than the dynamic moduli. However, if the experimental curves of these figures are extrapolated to zero stress, the dynamic moduli are within a few percent of the static values.

The dynamic method of determining the moduli of elasticity of materials is precise and sensitive although it does not require delicate or elaborate apparatus (20). The dynamic testing apparatus used was sensitive within 0.1 percent and the probable error of an observation is about 1 percent if proper precautions are observed.

The fatigue test. The concept of a variable dynamic modulus of elasticity in plastics is closely associated with a proper interpretation of fatigue-testing results. The two most common types of fatigue-testing machines used on plastics are the R. R. Moore rotating-beam type and the Krouse plate or sheet type (13, 5).

The Krouse machine is of the repeated constant-deflection type in which the end of a cantilever plate is oscillated by a cam-and-arm mechanism. In using this machine, the tacit assumption is made that the static modulus equals the dynamic value, which is contrary to the experimental data of Figs. 6 and 7. On the basis of the observed deviation between the static and dynamic moduli, the error involved in the calculated alternating stress produced by the Krouse machine, or any other repeated constant-deflection type of machines, may exceed 40 percent. The endurance to a specific alternating deflection may be more important than the endurance to a specific stress in some types of springs, for example. Thus, the constant-deflection type of machine may yield valuable information; but the results of a repeated-deflection fatigue test on plastics should not be given in terms of stress.

The variable dynamic modulus of elasticity also introduces some inaccuracies in the R. R. Moore machine. The stress in the rotating-beam type of machine is computed by the simple bending equation $S_d = Mr/I$, which does not involve the modulus of elasticity directly. However, in the derivation of this equation, it is assumed that the stress is proportional to the distance from the neutral axis of bending, which in turn assumes that the modulus of the material is constant at all stresses. On the basis of the observed decrease in dynamic modulus of elasticity with stress, Fig. 7, the outer highly stressed fibers will have a lower effective modulus during the cyclic stress.[6] Therefore, it may be concluded that the

[6] The change in modulus with increasing stress, or distance from the neutral axis, is probably not as large as illustrated in Fig. 7, because, after thermal equilibrium is attained, each point in the test specimen will have about the same temperature regardless of the local stress.

fatigue strength determined by the rotating-beam test cannot be safely used in design problems involving direct stress. The difference between the rotating-beam fatigue strength and the direct-stress fatigue strength is similar in nature, but probably not so great in magnitude, as the difference between the static modulus of rupture in bending and the static tensile or compressive strength. For reasons similar to those cited the fatigue strength obtained from torsion tests on solid rods is higher than that under uniform shear. This source of error is reduced by using tubular specimens.

The foregoing discussion was referred to plastics because the effects involved are particularly large for materials of high damping capacity. However, metals are also affected to a limited extent (see comparison of direct-stress fatigue strengths with rotating-beam fatigue strengths in reference 2). A quantitative analysis of the significance of the variable dynamic moduli of elasticity as related to the fatigue testing of plastics is now under way.

During a fatigue test, the specimen is well above room temperature, as indicated by Fig. 9. Thus, the fatigue strength determined is not that at room temperature but rather at some elevated temperature dependent upon the rate of heat generated within the specimen and that lost to the surroundings (16). The fatigue strengths of metals are changed only slightly by the temperature increase (2) which occurs during cyclic stress. The fatigue strengths of plastics are highly temperature-sensitive. For example, the fatigue limit of methyl-methacrylate resin is 2000 p.s.i. at 78° F. and 4800 p.s.i. at −38° F. Thus, in testing plastics such variables as frequency, size of specimen, rate of heat loss from the specimen and other factors affecting the specimen temperature will influence the observed fatigue strengths.

The behavior of methyl-methacrylate resin during a fatigue test illustrates the effect of temperature on the properties of plastics. The specimen *D*, Fig. 11, was subjected to direct alternating stress in the horizontal arrangement of Fig. 2. The stress was above the endurance limit, and, at the working frequency of 67.5 cycles per sec., the specimen warmed up to about 160° F. After about 500,000 cycles of stress, one spot on the specimen became hotter than the rest, probably reaching 250° F., and localized plastic flow soon caused a bulge or swelling there. Further stress cycles slowly increased the size of the swelling (see *S* in Fig. 11, specimen *D*), which soon reached a limiting size and stabilized. Measurement showed that most of the deformation in the specimen occurred in this swelling. After about 300,000 more cycles of stress, before actual fracture occurred at the first swelling and, even though the specimen was fan-cooled, a second swelling started about 3 in. away from the first, but again the specimen did not fracture. Finally, after 100,000 cycles additional, the specimen fractured, but not at either original swelling. It appears that high temperature at the point of potential or impending fatigue failure may in some way strengthen the material. Perhaps the mechanism of this strengthening process is similar to the heat-treating effect in metals.

The foregoing observations partially explain the unusual behavior of notched polymethyl methacrylate fatigue specimens. Tests show (4) that the endurance limit of a 60° notched fatigue specimen is 30 percent greater than that of an unnotched specimen of equal cross-sectional area. Although the greater strength of the notched specimen appears inconsistent with the usual understanding of stress concentration, the heat-treatment effects at the root of the notch may strengthen the material enough to make the difference.

In order to study general behavior of the damping capacity and dynamic moduli of elasticity before fatigue failure, several fatigue tests were run. Miscellaneous broken specimens are shown in Figs. 10 and 11. In nearly all cases observed an abrupt drop in both the resonance-amplification factor and dynamic modulus of elasticity occurred before any macroscopic cracks could be observed in the test specimen.

Conclusions

(a) The two oscillatory-type dynamic testing machines developed for this work provide a simple and effective means of studying the mechanical properties of materials under complete reversals of both direct stress and torsional stress. These machines overcome three limitations in the rate-of-vibration-decay method of measuring damping capacity; i.e., the effects of cyclic stress may be continuously determined, the damping capacity of any material under direct alternating stress may be evaluated and materials or structures with very high damping capacity may be accurately studied. Furthermore, a continuous record of the dynamic modulus of elasticity may be kept and complete fatigue tests may be run with these machines.

(b) The resonance-amplification factor for the plastics tested was about $^1/_{10}$ that of the metals.

(c) The stress induced by resonant vibrations in a structural member is proportional to the product of the exciting force and the resonance-amplification factor. Therefore, structural plastics with a low fatigue limit (about $^1/_3$ that of duralumin), and a much lower resonance-amplification factor, may actually be more durable than metals in members subject to large vibration-exciting forces. In some aircraft parts the superior vibration-damping ability and low density of plastics (about 0.5 that of aluminum and 0.18 that of steel) may make them an acceptable substitute for metals.

(d) Sustained cyclic stress below the endurance limit increased the resonance-amplification factor of the metals tested as much as 25 percent. Although the increase was rapid at first, the resonance amplification changed very little after about 100,000 cycles of stress.

(e) A pronounced reduction in both the resonance-amplification factor and the dynamic modulus of elasticity occurred at impending fatigue failure in all materials tested. This reduction was usually evident before any macroscopic fatigue cracks could be observed.

(f) For most of the metals tested the dynamic modulus of elasticity, under both direct and torsional stress, decreased a few percent as the alternating stress increased. The dynamic moduli were within a few percent of the static moduli.

(g) For the plastics tested, the dynamic modulus of elasticity under both direct and torsional stresses decreased as much as 40 percent as the magnitude of the alternating stress increased. However, the dynamic modulus at zero stress, obtained by extrapolating the experimental curves showing dynamic modulus versus stress, was within a few percent of the static modulus.

(h) Since the dynamic modulus of elasticity may deviate considerably from the static modulus, most repeated constant-deflection types of fatigue machines do not give reliable results on plastics.

(i) The high damping capacity of plastics causes a large amount of heat to be developed within the specimen during the fatigue test. The resulting rise in temperature may greatly influence the mechanical behavior of the plastic.

(Please turn to next page)

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Appendix

The "dynamic moduli of elasticity" refer to the stress-to-strain ratios effective during a vibration.

The "damping capacity" measures the ability of a material to absorb energy while being subjected to cyclic stress. Its magnitude is proportional to the area within the hysteresis loop caused by inelastic action.

The "resonance-amplification factor A_r" of a material is a reciprocal function of its damping capacity. Quantitatively, it is the ratio of the total force F_t (or torque T_t) in a specimen under resonant vibrations to the amplitude of the exciting force F_0 (or torque T_0). Materials displaying a large hysteresis loop possess a high damping capacity and a low resonance amplification factor.

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FOR SALE: 1—W.S. Hydro-Pneumatic Accumulator 2500 PSI, 8 gal., with IR m.d. compressor; 1—Hydro-Pneumatic Accumulator, 2500 PSI, 16½ gals., complete with tank, compressor and piping; 1—W.S. 15" x 18" Hydraulic Press, 10" dia. ram, 4" posts; 1—Triplex Hydraulic Pump, 11 g.p.m. at 2000# pressure, also others; 1—W.S. Hand Pump; 1—set of Compounding Rolls 18" x 44"; Adamson 6" Tuber; 7—W. & P. Mixers; Dry Mixers, Pulverizers, Grinders, etc. Send for complete list. Reply Box 446, Modern Plastics.

WANTED: Hydraulic Presses, Preform Machine and Mixer, Stainless Steel or Nickel Kettles, Vacuum Pan. No Dealers. Reply Box 275, Modern Plastics.

FOR SALE: 350 Ton Hydraulic Lead Wire Extrusion Press with Pump. 400 Ton horizontal Hydraulic Extrusion Press. Hydraulic Scrap Baler, 80 Ton, 6½" Ram, 90" stroke, 5000 lbs. per sq. in. Three J. H. Day #30 Imperial Mixers, double Sigma Blades, two steam jacketed. 75 ft. link belt conveyor, 36" wide. Large stocks of Hydraulic presses, pumps and accumulators, preform machines, rotary cutters, mixers, grinders, pulverizers, tumbling barrels, gas boiler, etc. Send for bulletins #138 and L-17. We also buy your surplus machinery for cash. Reply Box 439, Modern Plastics.

WANTED: Injection Moulding machine in good condition, 2 or 4 ounces. Give full details. Reply Box 657, Modern Plastics.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933, OF MODERN PLASTICS, published monthly at Easton, Pennsylvania, for October 1, 1942.

State of New York } ss.
County of Kings }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Chas. A. Breskin, who, having been duly sworn according to law, deposes and says that he is the Publisher of the MODERN PLASTICS and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:
Publisher, Chas. A. Breskin, 122 E. 42nd St., New York City.
Editor, Raymond R. Dickey, 122 E. 42nd St., New York City.
Managing Editor, Harriet B. Josephs, 122 E. 42nd St., New York City.
Business Manager, A. S. Cole, 122 E. 42nd St., New York City.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)
Breskin Publishing Corp., 122 E. 42nd St., New York City.
Chas. A. Breskin, 122 E. 42nd St., New York City.
Mrs. C. A. Breskin, 162 Brite Ave., Scarsdale, N. Y.
Linda S. Breskin, 162 Brite Ave., Scarsdale, N. Y.
Theodore B. Breskin, 162 Brite Ave., Scarsdale. N. Y.
A. S. Cole, 122 E. 42nd St., New York City.
E. F. Gregg, 195 Broadway, New York City.
S. Moisseiff, 99 Wall St., New York City.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are:
None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

CHARLES A. BRESKIN, Publisher.

Sworn to and subscribed before me this 8th day of October, 1942.

[SEAL] HERMAN L. ISLER
Notary Public, Kings County
Kings County Clerk's No. 11, Register's No. 4000
New York County Clerk's No. 36, Register's No. 4-4-14.

(My commission expires March 30, 1944.)

FOR SALE: BOILER. One 200 H.P., 200# per sq. inch, H.R.T. Boiler built by Pennsylvania Boiler Works in 1931. Complete with 75 foot stack, safety valves and water column. Retubed April, last., Mack Molding Company, Inc., Wayne, N. J. Tel. Mountain View 8-0800.

CHEMIST OR CHEMICAL ENGINEER with experience in manufacture and fabrication of thermoplastics interested in technical administration wanted as assistant to technical director. Reply Box 660, Modern Plastics.

WANTED TO BUY: 8 oz. capacity Injection Molding Machine, Reed-Prentice preferred. Nu-Dell Mfg. Co., 2250 N. Pulaski Rd., Chicago.

WANTED: Plastics Salesman by long established custom molding concern. Must be draft deferred and willing to travel. Apply by letter giving full details of experience, age, and salary desired. Reply Box 654, Modern Plastics.

PLASTIC GIFTS, NOVELTIES, AND HOUSEWARE ITEMS WANTED. Edward P. Paul & Co., Inc., 43 W. 13th St., New York City.

WANTED: 8, 10, or 12 oz. Injection Molding Machines—sale or rent. Write giving full particulars as to make, size, manufacturer's serial number, age, condition, price. Reply Box 655, Modern Plastics.

PLASTIC PLANT WANTED. Will pay cash for factory. State full particulars. Information held confidential. William Alton, 1133 Broadway, New York City.

PLASTICS ENGINEER WANTED: Must have experience in mold designing, estimating and plant management as well as a knowledge of molding compounds. This is an excellent opportunity for a man who can assume responsibilities that will be given to him. Position is now open. Reply Box 639, Modern Plastics.

WANTED: We have Government permit to buy acrylic scrap resulting from compression and injection molding. Highest price paid. Submit samples to Peters Chemical Mfg. Co., 3623 Lake St., Melrose Park, Ill.

SALES ENGINEER—Interested in transferring to reliable, progressive outfit who definitely wants to do a job on defense work. 9 years sales experience. Working knowledge of compression, transfer and injection moulding; stamping; impact extrusion; and drawing of metals. Last 3 years specialized on defense conversion. Contacts include drug, cosmetic, airplane, instrument companies, condenser manufacturers. Good drive and tenacity. Original ideas. Age 32, 3A classification. Reply Box 653, Modern Plastics.

MAN WITH EXPERIENCE IN MOLDED PLASTIC FINISHING OPERATIONS to design jigs and fixtures. Must be draft deferred and not presently engaged in war production. Write giving full details of experience, age, other qualifications, and salary expected. Reply Box 656, Modern Plastics.

POSITION WANTED: Chemical Engineer thoroughly experienced in fabricating and production of plastic materials. Knowledge of machinery and dies for compression, extrusion and injection molding. Executive ability to set up and operate plant. Draft exempt. Reference available upon request. Reply Box 658, Modern Plastics.

WANTED: Draftsman experienced in the design of Plastic molds. Good opportunity. Reply Box 652, Modern Plastics.

WANTED: A large manufacturing company in the Newark, New Jersey, area is contemplating opening an injection molding division and requires an experienced man to set up and operate this division. This will be a permanent position for a qualified man. Write to Box 651, Modern Plastics, stating complete experience, age and salary expected.

WOULD LIKE TO CONTACT a molding powder manufacturer or a manufacturer making plastic moldings who would be interested in having a mill erected in Canada. Have splendid location for a mill with the possibility of installing an independent 2000 horsepower station in the ground. Inquire Box #649, Modern Plastics.

100,000 lbs. Lucite powder ground from pearl rods in mixed colors at 20¢ per lb. Jos. H. Meyer Bros., 220—25th Street, Brooklyn, N. Y.

WOULD LIKE TO PURCHASE a four or six ounce injection molding machine. Reply Box 650, Modern Plastics.

FOR SALE: Motor Driven Air Compressor, Size 12 x 10, 260 cu. ft. displacement, 100 lbs. pressure. Reply Box 512, Modern Plastics.

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